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+ SEPTEMBER +
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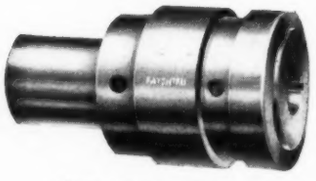
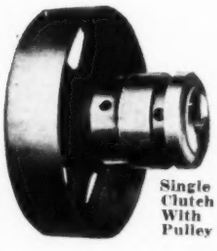
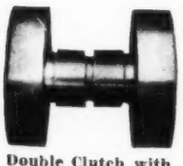


Single Clutch—Exterior



Single Clutch With Pulley



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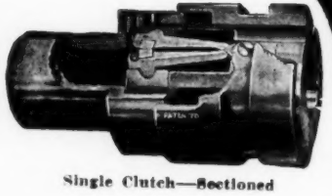
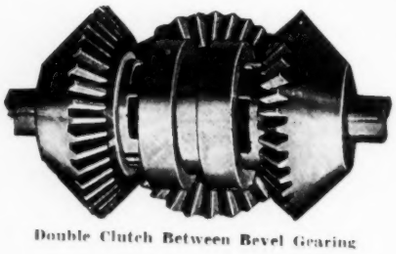


Single Clutch—Sectioned



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• PRODUCT ENGINEERING •

PRODUCT ENGINEERING

New York, September, 1931

A McGraw-Hill Publication

The Right Amount of Metal In the Right Place

By F. W. SLANTZ

Professor of Graphics, Lafayette College

BECAUSE of the type of service to which they are subject, there has been little change in the general appearance of frogs and crossings, as compared to other units of railroad equipment. Trackwork must function safely under all weather conditions, regardless of the terriffic impact set up by high speeds, and for this reason designs are necessary that do not involve moving parts.

In general, the designs of frogs and crossings are restricted primarily to a series of rigid gage and guard lines to guide the wheel flange in the desired path, and solid bearing surfaces on which the tread of the wheel can roll. The requirements necessitate rigidity in some directions, resiliency in others, and, above all, the ability to absorb shock without failure. Evidently, the problem of the design of railroad frogs and crossings is to select material that will best withstand the severe service of heavy traffic.

The story of the adoption of manganese steel for special trackwork is one of the interesting episodes in the history of engineering. In 1892, shortly after the discovery of manganese steel, the Taylor Iron & Steel Company, now the Taylor-Wharton Iron & Steel Company, secured from Hadfields, Ltd., of England, the right to make manganese steel in the United States. Great things were predicted for the material, and it was believed that it would make a superior car wheel. But test wheels proved it to be an utter failure for this purpose. The extreme hardness of manganese steel is developed only by cold

+ Structures of such shape that the stresses cannot be analyzed mathematically require laboratory determinations. Even then, the best design with reference to stresses will result in a defective product if its proportions cause difficulty in producing the article with sound metal throughout, free from residual stresses +

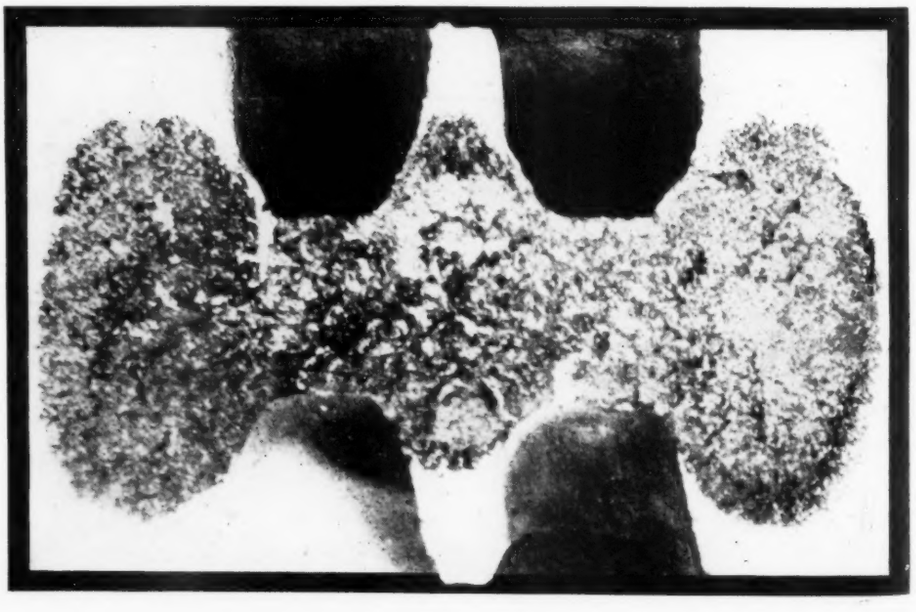
working in service. Such cold working is not received by car wheels, and the brake shoes and rails soon wore the tread and flanges of the wheels. However, special trackwork is exposed to the pounding of heavy traffic, and it was recognized that manganese steel used in frogs and crossings would receive the necessary cold working to give it the desired hardness to resist wear. At the same time its great toughness would give it the ability to absorb shock. This made it the ideal material for trackwork, and the company had little difficulty in selling this idea to William Wharton, Jr. & Co., Inc., who were pioneers in the manufacture of special trackwork. But the railroads were skeptical, and it was not until 1900 that the first manganese steel frog was installed. In the course of a few years, however, manganese steel was recognized as standard for special trackwork. Incidentally, it may here be remarked that this led to the amalgamation of the two companies into what is now known as the Taylor-Wharton Iron & Steel Company.

Early designs of manganese steel track castings were to a great extent influenced by what the foundry considered good practice from the manufacturing standpoint. This produced sections amply strong for the wheel loads and speeds to which they were subjected, and for a number of years manganese steel appeared to be the panacea for all special trackwork problems. As the weight of locomotives and cars and the number of cars hauled in each train increased, rails and fittings were made larger and stronger to meet the increased service demands. Crossings designed for special trackwork naturally had to conform to the larger dimensions of the heavier rails, thus resulting in stronger sections. Thus, there was a development in manganese steel special trackwork design that in a way enabled it to keep pace with the increased severity of the service to which it was subjected. However, under severe service occasional failures of manganese steel crossing intersections occurred, and this impressed the company with the advisability of a more intimate study, both from the standpoint of metallurgy and of design, of railroad crossings, particularly in the region of the intersection of gage lines and grooves.

The natural assumption was that the making of metal sections heavier under the tread surfaces and grooves, together with numerous vertical supporting members in the region of the intersection, would give the desired additional strength. This idea had been carried in some cases to a point where there was practically a solid block of metal in the region under the intersection. But mass does not necessarily add strength, and if not judiciously controlled and distributed, heavy masses will reduce the strength of the casting because of internal defects inherent to the design and originating in the process of manufacture.

An example of one type of defect resulting from improper design is the shrink cavity resulting from too much mass. The thinner sections and outer walls chill and set quickly after pouring, while the heavy mass in the interior is still molten. As the outer surface solidifies, it draws on the molten mass to supply the shrinkage, and the result is a cavity in the interior of the large mass. Quite frequently these defects are not revealed by any sign on the outer surface of the casting, and usually are not in evidence until wear on the sound portions has become sufficient to weaken the entire structure and cause complete failure.

In addition to the danger of shrink cavities in the region of unequal sections, it had been found that thick sections, even though made uniform,



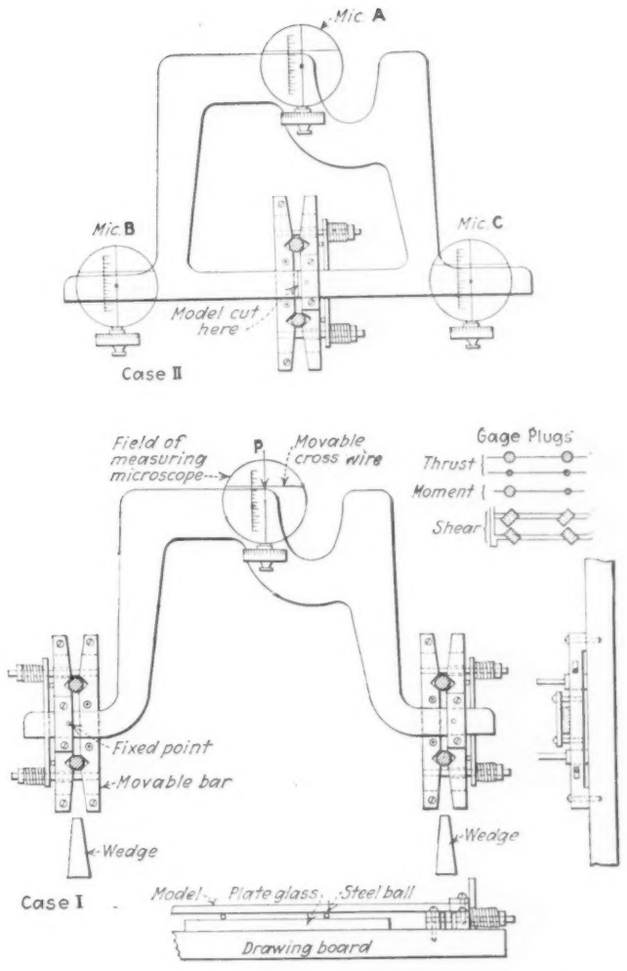
HEAVY sections in manganese steel develop internal cracks when heat treated

may develop internal defects in the heat-treatment of the manganese steel castings. In this process, the casting is heated to a high temperature and held in the furnace until the temperature of the casting is uniform throughout, and then quenched. If the sections of the casting are thick, it is obvious that the chill from the water will set up the outer surfaces and produce total shrinkage while the interior is still at a high temperature. The subsequent cooling and shrinking of the interior is likely to produce a concealed inner crack or what is known as "innercheck." In service, due to repeated and alternate stresses from the wheel loads, this check develops until it makes its appearance on the surface of the casting.

Realizing that a period had been reached in which the railroads were using equipment that would no longer permit the employment of "rule-of-thumb" methods in trackwork designs, it was decided to make a complete investigation. There were to be two distinct phases in the investigation: First, an engineering analysis to create a design that would afford minimum unit stresses in the structure when in service; secondly, a foundry and metallurgical study to determine just what cross sections could be cast and heat-treated with the assurance that the metal would be sound throughout.

It was soon found that the stresses in the cross-section were mathematically indeterminate, and, therefore, some experimental method of analysis would have to be applied. At this time attention was drawn to the work of Professor George E. Beggs of Princeton University, whose research and development of methods in the analysis of stresses in bridge arches had revolutionized the design of bridge structures. It was recognized that the Beggs' Deformeter method of stress analysis could readily be applied in the study of the stresses in railroad crossings. The services of Professor Beggs were therefore obtained and, in cooperation with him the study of crossings was made by the author at the company's plant.

To make a stress analysis of a structure by means of the Beggs Deformeter, a model of the structure or a cross-section is made, usually of celluloid or cardboard of a fine quality and constant thickness. The members of the model are given the same proportions of stiffness as those of the actual structure by making the width of the model members proportional to the cube root of the moments of inertia of the actual cross-sections. Using a homogeneous material, the ratio of deflections between model and structure is independent of the coefficient of elasticity.



ARRANGEMENT of gages and micrometer microscopes for making stress analysis. Above, crossing section closed at the base with a tie bar. Below, a section without tie bar

In the accompanying figure is shown how a model is mounted on a drawing board with the Beggs Deformeter apparatus set up for the investigation. One of the two bars of the gage of the deformeter is screwed to the mounting board, and the movable bar of the gage is attached to the model by a clamping plate if the support is fixed, or by needle point if hinged. The two parallel bars of the deformeter gage are held together by coil springs that permit a small relative motion between the bars.

For the unstrained condition, two "normal" plugs are inserted in the opposing V-notches of the gage bar. A filar micrometer microscope is set up over the assumed point of loading, with the fixed crosshair of the microscope set parallel to the direction of load by sighting a scribe mark on the model. To find the relative magnitude of the vertical component of the reaction in terms of the load, smaller round plugs are inserted in place of the normal plugs, causing a vertical displacement at the clamp. The crosshair of the microscope is then brought tangent to a reference mark on the

model and the initial reading taken. Round plugs larger than the normal plugs are then inserted in the gage, causing a definite deformation of the elastic model and a displacement of the reference mark. The crosshair is again brought tangent to the reference mark and a second reading taken. The difference between the initial and second readings will be the displacement of the reference point in the direction of the assumed load.

As in any leverage system, the product of force times displacement of the point of application measured along the line of action of the force must be equal to the load times its displacement. Thus, the product of the assumed load times the deflection as measured by the microscope must be equal to the reaction times its known vertical displacement, as measured by the difference in the diameters of the gage plugs used. Thus for any assumed load, the corresponding reaction can readily be calculated. In a similar manner, the horizontal component of the reaction may be determined by using the gage plugs for shear, thus obtaining a horizontal displacement at the support.

+ + +

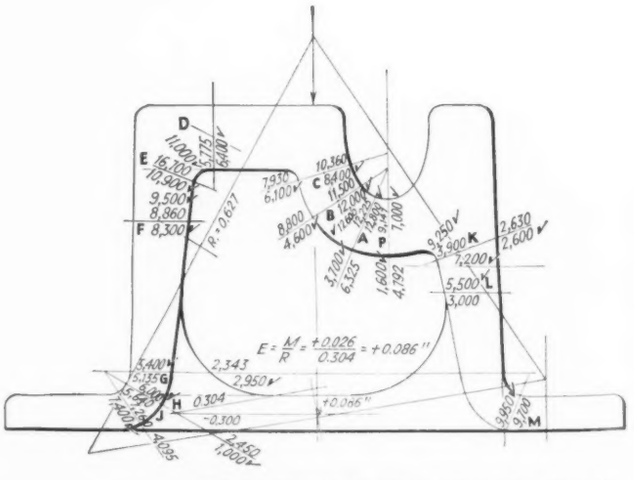
Impact resistance increases with yielding and uniformity of stress distribution. Excess metal causes increased stiffness and wide stress variations. Hence the necessity for accurate stress determination for structures subject to dynamic loads

+ + +

For the determination of moments, one large plug and a small plug are inserted in the V-notches, twisting the support a known amount. Measuring the displacement of the load in the direction of its line of action, the bending moment that would be produced is calculated, being the product of the assumed load times the ratio of the deflection of the load times the twist measured at radius unity. Where the model has been made to proportionate scale, the moments thus calculated must be multiplied by the ratio of the linear dimensions of the structure to the corresponding linear dimension on the model. This does not apply when calculating the horizontal and vertical components of the reaction.

In this investigation of the stresses in railroad crossings the point of loading was determined from actual service records and observations in the experience of the company and from the records of the A.S.C.E., the A.R.E.A., the A.R.A., and similar sources. A wheel loading of 50,000 lb. was assumed. This included 25 per cent for impact, and is in excess of the service loading by at least 50 per cent. The greatest wheel loading for electric locomotives is about 37,500 lb. For steam locomotives of the mikado type, the maximum load on the rear drivers is about 30,500 lb. The assumption of a wheel load of 50,000 lb. including 25 per cent for impact, distributed over 18 in. of rail length, is high enough to insure a large margin of safety in calculations of maximum stresses. Under service conditions the maximum requirements for speed, curvature, and impact will not be encountered simultaneously, but were assumed to be so in this investigation. Models of the crossing section were drawn full size on white cardboard and these were fastened to wood backing and cut out with great care.

The tests were based upon a comprehensive series of model studies in which all variations of cross-section of typical crossing frogs were investigated. In addition to the conventional sections then in use, the study was made of widely varying sections, and from this analysis the most desirable sections were determined. To obtain a check on the results of the investigation, Professor Mortimer F. Sayre of Union College was commissioned to make an independent study of the distribution of stress in a number of typical sections selected at random. There is a remarkably close agreement between the stresses as analyzed by means of the Beggs Deformeter and the fibre stresses as arrived at by Professor Sayre using the photo-elastic method of analysis by polarized light. An accompanying figure shows the stress distribution in a typical modified section, the



FIBER stresses in the section of cast manganese steel crossing. Checks indicate photo-elastic analysis, other figures obtained by Beggs Deformeter

CAST manganese steel crossing as developed on the basis of stress analyses made by the Beggs Deformeter

checked figures being fibre stresses as determined by the photo-elastic method, and the other figures being those determined by the Beggs Deformeter. The close agreement between the results obtained by the different test methods indicates the accuracy obtainable by either.

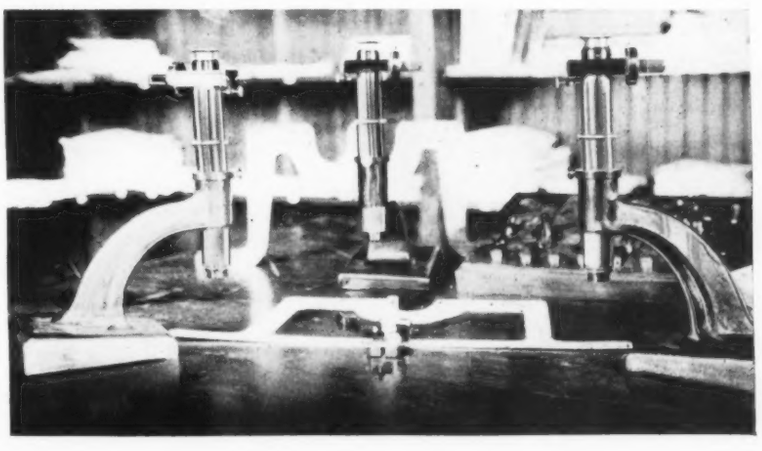
In the conventional sections in use, before the study was made, there were locations which under service loading were subjected to stresses of from 30,000 to 46,000 lb. per sq.in. By changing slightly the thickness of the metal at these points, the stresses were decreased from 40 per cent to 50 per cent in the modified section. In other places, the section of metal was found to be thicker than necessary so that it was possible to reduce the thickness at these points in the modified section. In general, the study made possible a redistribution of the metal so that in the crossing, redesigned to meet the theoretically correct design for service loading, proved to be only slightly greater in weight than the old conventional type, with all maximum stresses far below elastic limit of the steel used.

The ideal crossing design which was adopted is one in which the cross-section in the region of the intersection of grooves resembles a hollow box with the lid in place, the metal under the tread surface and grooves being of uniform thickness, and not supported by any vertical members other than the side walls. The side walls are tapered, the thinnest portion occurring where they join the bottom or base flanges. The side walls are joined together by a bottom plate, or in some cases, by reason of the angle of the crossing, joined merely by horizontal tie bars. All the features of the new Wharton crossing have of course been covered by patents.

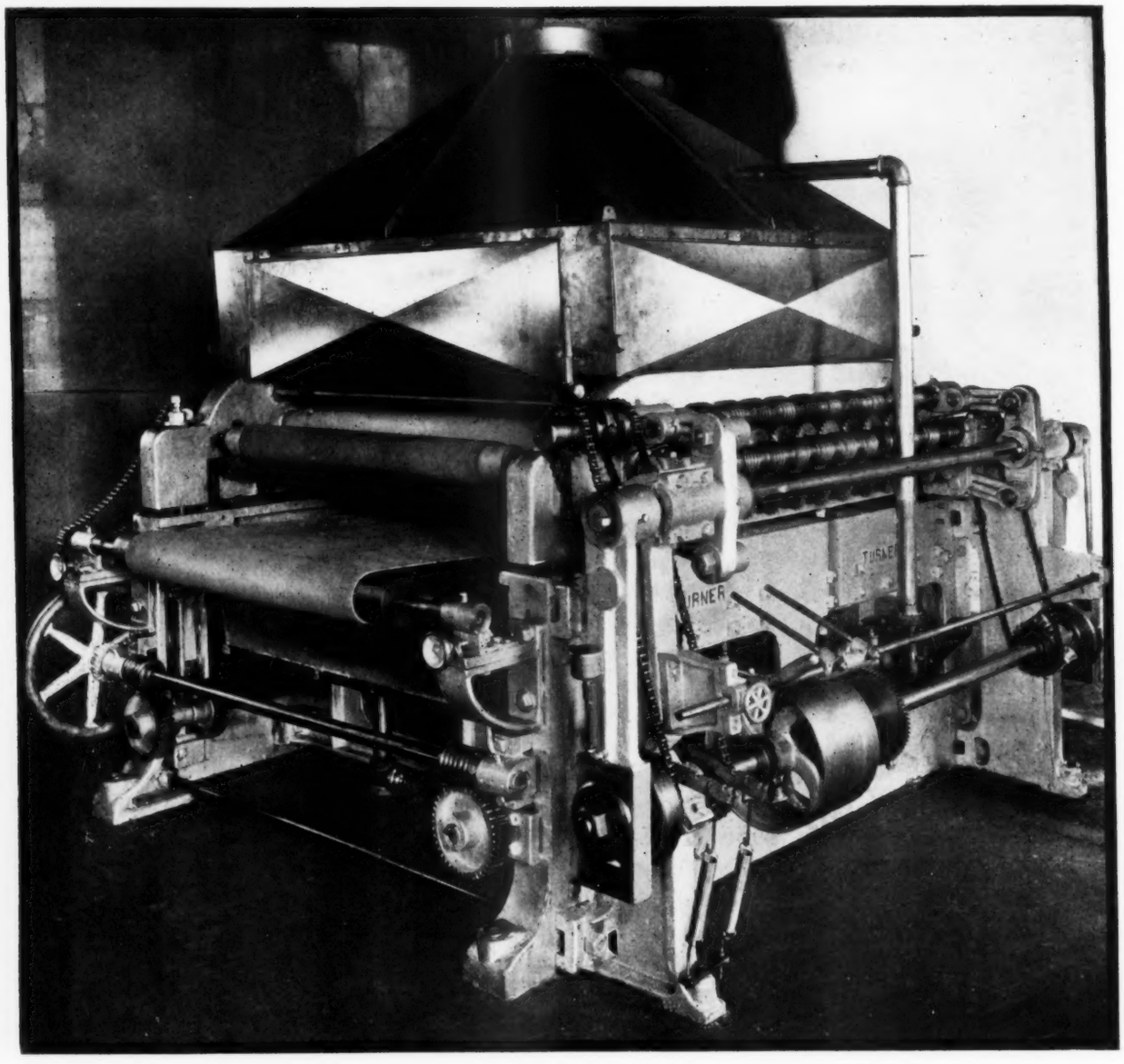
In order to prove the practicability of the design from the casting standpoint, full size models were made from manganese steel and tested to destruction. The results obtained not only proved the design to be consistent with good manufacturing practice, but also proved the additional strength indicated by the theoretical analysis. An outstanding feature of the new design was that, in breaking, the metal tore gradually and the casting was bent up to an angle of 40 deg. before it broke in two. Some of the more heavily reinforced types of which life-size samples were also made for bending tests, being more rigid, withstood deflection to a greater extent, but snapped at a much lower pressure.

The gradual tearing under heavy load proves the resiliency of the new design, a quality necessary in track structures to withstand the alternating flexure produced by the action of rolling wheels. Furthermore, when defects do occur, if a crack tears or develops slowly, the casting will not give trouble before the defect is discovered; whereas if it is a stiff, unresisting structure that snaps in two, danger is ever present. Since the adoption of this design by the Wharton company, over 300 crossings of this type have been placed in track, resulting in service records that are highly gratifying and indicating the superiority of this scientifically designed product over the former crossings designed by "rule-of-thumb."

✦ ✦ ✦



BEGGS Deformeter apparatus set up for analyzing stresses in a railroad crossing



MULTI-ROLLER for shrinking and felting hat bodies in boiling acid solution

Mechanizing a Difficult Process

✦

By GEORGE H. MIDDLETON

Engineer,
Danbury Factory, Turner Machine Company

✦

THE function of the Multi-Roller, the machine here described, is that of performing the operations of shrinking and felting hats by mechanical action. This was originally a laborious operation, requiring heavy work in an unhealthy atmosphere of boiling acid solutions. On its proper performance depends the success of one of the most important operations in making a good felt, and a fundamental requirement is a copious supply of boiling water during the rolling action.

A brief description of the materials and processes of hat making will aid in visualization of the requirements of hatting machinery. Hats are now chiefly made of fur, generally obtained from rabbit, hare, muskrat, nutria, or beaver, in that order of plentifulness and cheapness. The skins are cleaned, softened and chemically treated

to improve felting qualities, then cut from the back of the fur, which is packed and graded for quality (age, length of fiber, color, etc.).

The hat manufacturer takes the raw fur, mixing various grades according to quality required. This is blown and opened up to free of dust, clots (or dags) and leave each fiber clean and independent. The blown fur is weighed out into one-hat quantities, and in a machine known as a former, is projected like a cloud of snow onto a perforated cone 24 to 30 in. in height, below which is a suction which draws the fur evenly into shape. The cone is then dipped into warm water or sprayed, and the loose fibers cling to each other, giving a thin mat of fur that will hold its conical shape, the "body," as it is called by hat makers.

The next process is shrinking and felting on the Multi-Roller, for it is found that repeated rolling, squeezing or other mechanical treatment causes the fibers to work into each other and lock tighter and tighter until the resulting felt is very tough. The mechanical treatment can, of course, be more severe as the felt gets tighter, and the processes are materially assisted if performed in hot or boiling water; slightly acid water giving still quicker results. The operations are continued until the delicate "body" has been reduced in height from 27 in. to about 15 in., with consequent increase of thickness and toughness, at which stage it is ready to be treated as a finished body and to go through the finishing processes.

The Multi-Roller must be strongly and heavily built. It consists of a stiff cast-iron main frame held together by cross stays and tie rods. Above each main side are the roll frames, lower and upper, both mounted on spherical-ended pins of hardened steel which engage in hard steel cups and permit the frames to rock sideways. The lower frames are set at a fixed height above the main sides, but the upper frames are supported by handwheel-controlled racks set at each corner. This permits raising the whole top frame for cleaning, removing or changing of rolls; while lowering the frame causes the rolls to come together and thus increase the pressure on hats passing between them. The upper roll frames are made especially heavy, and in combination with the rolls weigh about 2,000 lb. This full weight is available for pressure if desired in the making of a particularly light felt.

On the right side of the frame are fitted the driving mechanisms. The lower shaft is driven through tight and loose pulleys, or from a motor by silent chain or short-center belt drive. This shaft in turn drives, through roller chain and sprockets, worm shafts on the upper and lower rolls, which are of opposite hands to give the rolls their correct rotation. The babbitt bearings are of ample dimensions to give low unit pressure.

At the ends of the main drive shaft are heads with dovetail slots and bolts, working as small-throw cranks in the long swinging arms that can be seen in the illustration. These operate a rocker shaft which carries two double arms of equal radius, the lower ends of which are coupled to the lower roll frame, the upper ends to the upper roll frame. There are ten rolls in the upper frames, and eleven in the lower, set alternately, so that the hats are compelled to follow a sinuous path, the flexing thus given assisting shrinking and felting. The motions given to the rolls are a combination of rolling and transverse action, as they rotate steadily forward, while at the same time they receive, through the frames, a harmonic

MEDIEVAL processes for making felt hats were standard up to about 70 years ago; then John Turner began to develop machinery that would eliminate some of the laborious and unhealthy operations. For many years progress was slow, partly because the specialized labor of the industry looked unkindly on machinery, but also because it was not until very recently that suitable hot-acid-resisting materials were available. To bring the highly specialized operations of hat making under mechanical control has called for unusual experimentation and engineering design because of the varying nature and reactions of the material, but as a result of a continuous product development program, the Turner Machine Company has at the present time designs and patterns for 200 different machines for doing the 60 to 70 operations on a fur hat. This development program, instrumental in the growth of the world's largest hat machinery organization, will continue, as in the past, to take advantage wherever possible of the latest improvements in mechanical units and materials made available to industry.

LELAND D. WHEELER
President, Turner Machine Company

motion or "jig" to and fro, always in opposite directions, in order to carry the body properly.

The liquor pump is mounted on the side of the main frame and is driven direct by gearing. It pumps the boiling water from the supply tank (steam heated) below the rolls upward and over to the center of the machine. There a distributor spreads it over a finely perforated plate which in turn sprays the whole surface of the rolls. Thus the hats are constantly in a stream of boiling water, and the water is collected and drained back into the tank below the rolls. The machine is kept hot by the ascending steam.

Occasionally acids are added to the boiling water to aid shrinking, the usual acid being commercial sulphuric in a 6 per cent solution. Sometimes acetic acid is used if hats are worked in the colored state, as this acid helps not only shrinking but fixing of the color. It will be obvious that to meet the severe conditions of motion under hot acid solutions, lubrication and resistance to corrosion must be provided for carefully. Grease is employed for lubrication as it holds against washing better than oils and stays in place better without splashing. This is essential, as a spot of oil on a hat ruins it completely. The Alemite Zerk system was therefore adopted throughout, except on the crankpin blocks, where oil cups are provided to allow a steady drip for continuous lubrication.

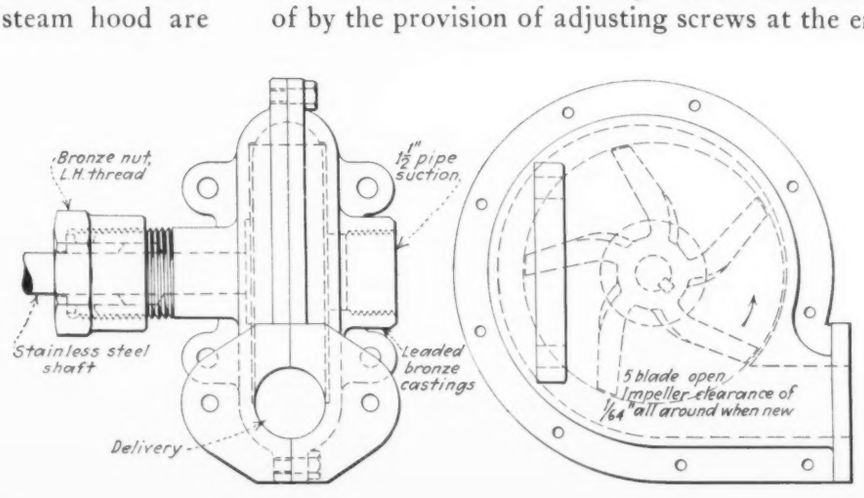
To prevent corrosion, bolts, tie rods, and other parts are of stainless steel wherever they are likely to come in contact with the hats or the liquid. The pump is of the open impeller centrifugal type with forward curved blades. With the exception of its stainless steel shaft it is all acid-resistant bronze (approximately 88-4-4-4 in composition) and close clearance between impeller and casing, minimize slip. The pump is designed to supply a stream of 75-80 gal. per min. at its speed of approximately 900 r.p.m. to the machine rolls.

The tanks, spray plate and steam hood are made alternatively of copper, Monel or stainless steel according to customer's wishes, as it is found that operators frequently have their own ideas of which is most suitable. All iron parts are first given a coat of elastic acid-proof paint, followed by an aluminum varnish as a finishing coat.

The first rolls used were composed of a series of sleeves of hard wood on a lead-covered shaft, screwed tight together by a lock nut. In the early days of the present design the rolls were covered with a hard vulcanite, but while the hats were felted, the jig action was slow and production was not as high as expected. A later development was to make thin wood disks of correct bore and diameter, threading them on the shaft so that the grain was arranged alternately side and end, then squeezing them tight under high pressure and locking with a fine-thread nut. When the water soaked into these disks the swelling of the wood across the grain gave the effect of a serrated roll. The serrations gripped the felt and carried it sidewise back and forth under the action of the jig and greater production resulted. The disadvantage of the wood rolls is their tendency, in color working, to absorb some of the previous color, and there is a chance that it will work out and spoil later colors.

On discussion with the rubber manufacturers, it was found that their experience had given them a basis on which to commence experiments for our problem. Pickling shops of the steel mills had called for rolls to squeeze off the acid on steel sheets, and the acid-resisting rubber used on the rollers was a good starting point for hat machine rolls. With slight modifications for taking care of the stickiness which this original rubber showed at 212 deg. F. and a change in the color of the stock, we had very serviceable rolls for the new machine. They stand up under hot water, while at the same time the homogeneous nature of the rubber insures clean work and no chance of color mixing. This type of roll is now most used, giving excellent results in quality, production and cleanliness, but some still prefer wooden rollers.

An interesting mechanical point was taken care of by the provision of adjusting screws at the end


Bronze nut, L.H. thread
1½" pipe suction
Stainless steel shaft
Leaded bronze castings
Delivery
5 blade open impeller, clearance of 1/64" all around when new

EIGHTY gallons per minute of hot acid solution are pumped between the rolls of the machine. An open impeller is required to keep clear of matted fur

of each roll. It was found that, although the jig is only small—approximately $\frac{1}{8}$ to $\frac{3}{16}$ in.—and the speed about 280 r.p.m., the inertia of the rolls and resistance of the hats to transverse motion would allow the frames to move, while the rolls stayed stationary, sliding in their babbitted bearings. This, of course, meant loss of production, so provision was made for each roll to have adjustment which will permit of free rotation, yet constrain it to jig with the frame.

At the first inception of a machine for shrinking and felting, labor was cheaper and it was usual to have three operators. One fed the hats into the front rolls, one collected them as they left the back rolls, and the other carried them back to the feeding operator, occasionally holding up production to perform the operation known as "crozing" or refolding the hats to prevent a ridge being left in the finished body where the fold occurs. This method became very costly in labor charges, and the quality of felt produced was diminished by the cooling off of the bodies during the operation. Below the working rolls has now been embodied a long conveyor, extending the full length of the machine. This serves a double purpose. Hats leaving the back end of the machine drop by gravity onto the return conveyor and are returned to the operator. They are returned in the same position and order as they were fed in, at a height of about 10 in. below a newly added wide feeding apron, and can be picked up and put on the apron correctly and rapidly for repeated operation. This greatly increases production in putting the hats through the 16 to 24 passes required.

Another advantage was gained by passing the return conveyor between the tank of boiling water and the working rolls where a constant stream of water is pumped. The hats are thus kept saturated by the water, and the temperature is held at its working value by the steam rising from the tank immediately below. The continued hot, saturated condition from beginning to end of the operation materially improves the quality of the hat produced, and also assists in making a further saving in time.

To overcome the necessity for crozing the hats was more difficult, but was finally solved by driving the upper rolls at a higher surface speed than the lower. This causes a relative motion of the upper surface of the hat body over the lower one, with the result that the folded edge is constantly changing its position and marks do not appear.

Only the smallest practical amount of relative speed increase in the upper roll is used as the hats are pulled out of shape if there is too much. The conical hat body should be worked with a gradually decreasing motion from the broad base of the cone to the almost pointed tip, but with parallel rolls a mean value has to be chosen which is a little small at the brim and a little too much for the tip. This, however, fulfills its function without spoiling the shape beyond chance of simple correction. Should the point of the hat be fed through first the higher speed of the upper rolls will pull the hat out of shape, so a double drive and clutch are provided whereby the rolls can be driven equal speeds for tip feeding, and different speeds for side feeding. This clutch can the thrown while the machine is running and is placed conveniently at the operator's right hand. It saved time by reduction in crozing.

These new features called for some interesting mechanical treatments. The difficulties of holding a wide conveyor apron are considerable, but the rubber surfaced drive and follower rolls and swivelling bearings having fine adjustments with stainless steel screws, have reduced the troubles of driving the canvas-rubber apron to a minimum. The apron is perforated at intervals to allow return of water to the tank.

Some hat makers call for more return space for the water, and to meet their needs a special slat apron has been developed. Wood slats about 1 in. wide and 42 in. across are carried by three rubber-covered canvas belts. These belts are specially made with an outer covering of $\frac{1}{16}$ in. thickness of vulcanized rubber, and are made endless so as to keep the acid water from reaching the canvas backing. In this case the aprons are carried on stainless steel shafts with special bronze pulleys for the belts. Other methods have been tried but the two given have proved most satisfactory.

Ball bearings have not been used in this machine at all for the reason that the speeds are relatively slow, main shaft 280 r.p.m., worm shafts about 220, and rolls 10 r.p.m., while the rocker shaft merely vibrates the small amount necessary to give the jig required. Babbitt of fairly high lead content has been found to give good service. To apply ball bearings under the conditions of humidity and acid vapor was not satisfactory, as it was found that even elaborate seals will allow the vapor to work through and condense on the bearings. After practical trials of ball bearings, it was decided in this case to retain the plain babbitted bearings.

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Trends in Product Engineering

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Design trends in many fields, illustrated by practical examples including a shock-insulated trolley bus, a centrifugal saturating and drying paradox, a "bichronous" clock, an aluminum boom, a battleship gyro, relative popularity of auto colors, a battleplane and what it might have been

PASSENGER comfort and safety, prime considerations in vehicle design, are particularly well exemplified in the new Osgood-Bradley trolley bus. Eddy or stray currents in trolley bus bodies have often caused electric shocks to passengers as they entered or left the coach. This bus has heavy rubber step treads, a battleship linoleum floor, and Micarta covered stanchions to prevent this. Special conduits inside the coach, lead sheathing and other means have been applied also to eliminate sources of current leakage. All doors are likewise insulated. Mudguards and splash aprons are of molded rubber with canvas insert. Main controller equipment is concentrated in a cabinet at the rear end of the body below the transverse seat. This formerly created noise in the otherwise well noise-insulated coach and consequently has been lined with Celotex. Trolley poles have rubber noise insulation as well as electrical insulation. The air compressor for the brakes is likewise set on a rubber

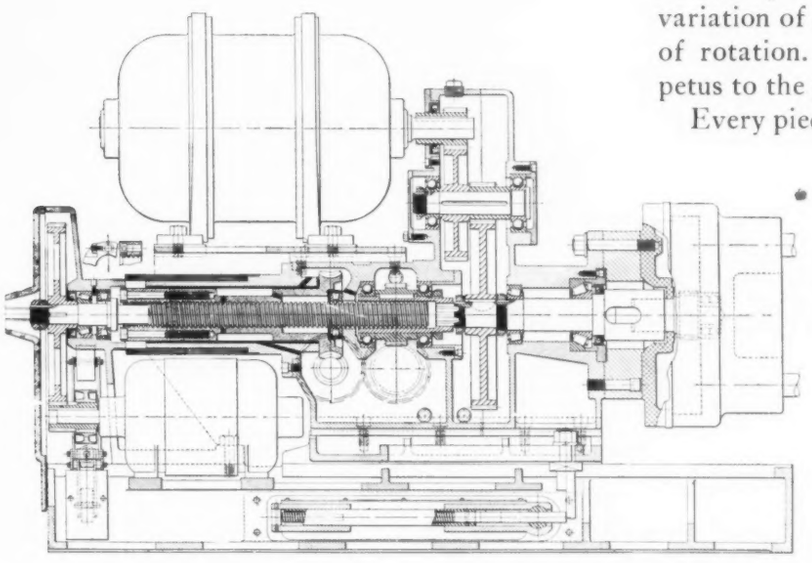
noise insulating pad. Electrical switches are in an aluminum cabinet at the driver's left, as far from the door as possible, and the control cab is insulated. Other notable design elements are shatterproof windshields, rear cross seats back-to-back over the rear axle housing and Trico double-blade windshield wipers.

Hammond engineers have done it again! Not satisfied with bringing out a synchronous clock incorporating a calendar, a kit of parts whereby any clock could be made synchronous, and introducing various other innovations that have proved practical enough to become sales successes, they have now produced a "bichronous," or dual movement, clock operating on the synchronous principle, and which, in addition, continues to keep accurate time when the current is off by means of reserve spring power, for interruptions up to 30 min.

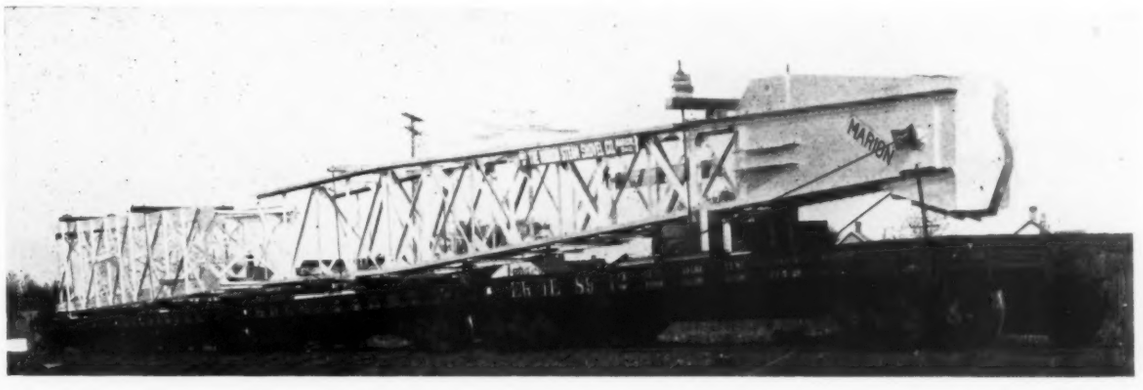
Gyro-stabilizers, applied until now only to yachts and passenger ships to increase the comfort of passengers by lessening roll, are expected to aid ship gunners on the new Italian destroyer *Pigafetta*. The engineers expect the stabilizer not only to improve marksmanship by reducing roll in rough weather, but also by using the stabilizers to create rolling, to give the guns longer range in a calm sea because of the higher gun elevation gained thereby. The stabilizer is also an economy device since it is estimated that a 20-deg. roll is equal to a 10 per cent loss of power. The rotor is a 38,000-lb. fly-wheel, 91 in. in diameter, 22 in. thick at the rim, and having a maximum speed of 3,350 r.p.m., giving it a peripheral speed of 32,000 f.p.m.

Speaking of centrifugals, a new industrial centrifugal introduced by engineers of the Leon J. Barrett Company can be used for a wide variety of processes, including washing, drying, extracting, saturating, coating, and impregnating small parts. In other words the same design will force liquids out of, into, through, or onto surfaces of materials simply by a change in the bowl or container. The entire rotating unit is positioned on a ball-and-socket universal in the base of the machine and is designed to sway under control about a vertical axis. This design confines pulsations to the container by focusing the vibrations through the ball in the base. It has been found that the amplitude of this oscillating movement, which is always in evidence, caused by variable or unequally distributed loads, will cause the articles in the container to be subjected to a pulsating pressure, due to the variation of hydrostatic pressure at different radii of rotation. These pulsations give decided impetus to the penetrating effect of the liquid.

Every piece of equipment for the "Akron," new



BAUSH all-electric center-feed drilling unit. One motor drives the drillhead, another the quick infeed and return mechanism, working on the feed screw itself and not on the nut



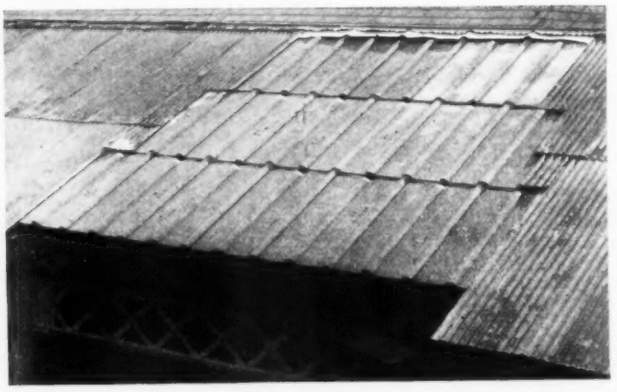
DURALUMIN boom for a Marion dragline excavator, weighing 34,400 lb. instead of 51,000 if of all-steel construction. The saving makes possible a 25-ft. extension on this 150-ft. boom and an increase in bucket capacity without exceeding permissible weight

Navy dirigible has been designed to have the least possible weight and to occupy the smallest space. So vital are the weight and size factors that certain equipment awards depended upon them. For instance, through liberal use of aluminum alloys the small winch motors to wind the antenna weigh only 20 lb. instead of the usual 30. Fuel pump motors weigh 65 lb., but those for the Akron weigh 50 and occupy 20 per cent less space. The 3,000-volt, 3,400-watt motor-generator set for the radio transmitter weighs but 250 lb. The 14-in., 380,000-candlepower signalling searchlight weighs less than 13 lb. including 20 ft. of cable, while the 42-in. wide, 35-in. high, and 12-in. deep switchboard for controlling all electrical circuits including power and light weighs but 200 lb. with 2,170 ft. of wire.

Welded construction vies with cast or riveted in a still wider variety of fields. The largest welded steel condenser ever built is now being constructed by Westinghouse for New Jersey Public Service. It is a 65,000-sq.ft. condenser of the single-pass, radial-flow type to serve a 75,000-kw. turbo-generator. For several years station and consulting engineers have been showing interest in welded steel plate construction, but only after extensive tests and design studies is it being utilized.

Colors still battle with black for greatest popularity in automobile finishing, as recorded by the DuPont color index. The rounding out movement of black for June developed into a definite decline in August, the first recession of this color in five months. It appears probable that color, with blue the leading contender, will supersede black before the end of the year.

It is strange that airplane colorings have succeeded somewhat better in tearing away from tradition. Most planes are highly colored. Incidentally, a chief topic at a meeting of Department of Commerce officials and manufacturers' representatives soon will probably be the increased use of metal in aircraft. In the same field, Curtiss has developed an unusually small Navy shipboard combat plane. Powered with a 400-hp. Wright Whirlwind engine, the XF9C-1 was designed to be the smallest airplane that could be built around the compact Wright powerplant, with the pilot and required military equipment. By this procedure, two important advantages have been gained; the plane occupies less space on the deck of a carrier, allowing more machines to be accommodated, and maneuvers more quickly in the air. This latter advantage enables the pilot to "get on the tail" of his adversary. Were it not for this requirement and the necessity for speed and a high rate of climb, it is conceivable that the air forces of the world might have had their engineers develop great turreted flying machines, analagous with the battleships and cruisers of surface fleets. The XF9C-1 has a metal monocoque fuselage, the skin being formed of dural sheets riveted together and braced internally by dural bulkheads and longitudinal members. The ship is a biplane with wings of the gull type fairing directly into the fuselage and eliminating cabane bracing. Spars are of tubular dural, ribs of stamped dural, wing covering of fabric. Ailerons appear on the upper wing only and there are no exposed aileron operating struts. Tail surfaces are metal covered and faired into the fuselage.



STANDARDIZED foundry designs will make possible quantity production of this cast-iron plate roofing developed by the U. S. Pipe & Foundry Company for heavy-duty roofs subjected to heat and corrosion. Standard plates are 2x4 ft., weigh 78 lb. apiece, and are held together by a cap plate covering the 1-in. edge flanges of the sheets

What can be accomplished by streamlining of high-speed vehicles is seen in the new automobile designed by Sir Dennistoun Burney for the Prince of Wales. The front of the car rises in a sweep from the wheels to an arched roof and slopes to the rear like a dirigible. The windshield is at an angle of 45 deg. The designer claims a saving of 50 per cent in horsepower required on a level road. Incidentally, the engine is in the rear, like the car proposed on page 574 of the December, 1930, number of *Product Engineering*.

The super airplane being built for the British Government at the Vickers Works will measure 174 ft. from tip to tip of the wings. It will weigh about 35 tons, and is largely of duralumin. The main spar structure is of stainless steel. The plane will have six 900-hp. Rolls-Royce engines designed to give a speed of 145 miles per hour. The maximum cruising range is 1,300 miles.

Oil Well Equipment

Some design problems

By E. N. KEMLER and R. L. CHENAULT

Engineering Division, Gulf Research Laboratory

WHEN the pumping of oil from wells was first started, it was only natural to adopt the plunger pump, and this type has continued to be used almost exclusively for wells in which the fluid level is at any great distance below the surface.

In operating an ordinary deep well pump, the crank is driven either by a motor through a speed reducer or by a gas engine through a countershaft. Often several small producing wells are driven by one prime mover through a cable system. The crank, rotating at 20 to 30 r.p.m. and having a stroke up to 6 ft., drives the walking beam through a pitman. The piston is actuated by sucker rods which connect to the walking beam through a polished rod of larger diameter than the sucker rods. The upper end of the polished rod travels in the arc of a circle described by the end of the walking beam, while at the other end the rod extends through a stuffing box and into the welltubing where it attaches to the sucker rod. Nearly a straight-line motion is given to the rod by using a long walking beam. This minimizes the bending of the polished rod and the wear on the stuffing box.

The sucker rods, only about $\frac{3}{4}$ in. in diameter, are pulled on the upstroke and fall under their own weight on the downstroke. Since they are usually up to several thousand feet in length, it would be impossible to subject them to compression without buckling. In order to keep the load balanced on the up and down strokes, counter-balance is applied somewhere in the system, usually on the walking beam, or on the driving crank.

Because of the heavy loads, trouble is often encountered with the sucker rods in deep wells, and this is the factor that sets a limit on the depth of wells to which the plunger type pump can be applied. For example, if a plunger pump were to be designed for a 6,000-ft. well, it would be subjected to a hydrostatic pressure of about 2,200 lb. per sq. in. About 800 lb. per sq. in. would have to be allowed

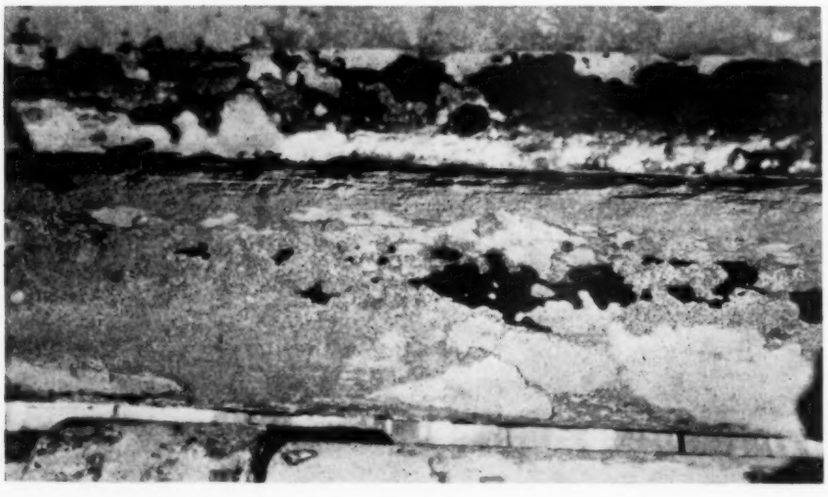
for the friction head necessary to move the oil, making the total pressure 3,000 lb. per sq. in. For a piston area of 2½ sq. in., the static load on the rods would be 7,500 lb. The weight of 6,000 ft. of ¾-in. sucker rods would be about 10,000 lb., making a total of 17,500 lb. static load on the rods. If the maximum acceleration of the oil and rods is 16 ft. per sec. per sec., about one-half the acceleration of gravity, the accelerating force required would be one-half the static load, or 8,750 lb., making a grand total of 26,250 lb. tension on a ¾-in. rod. Evidently, for such a well the material used for the rods would have to have an endurance limit of not less than 60,000 lb. per sq. in. in order to stand up under service.

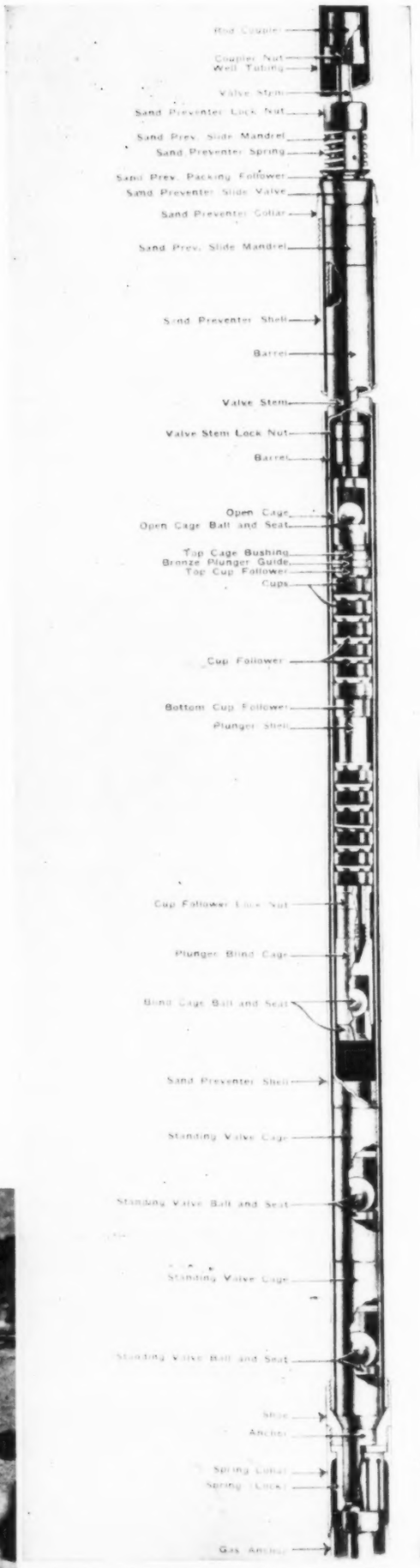
Not only are these rods subjected to shock and reversing loads, but also frictional resistance and bending because the well-holes are often crooked. Corrosion, erosion, and hydrogen sulphide embrittlement are also encountered. The loads on the rods may, of course, be reduced by using a smaller diameter pump, but that means smaller production, which is not desired. If wells of such depths are to be produced by plunger pumps, a material will have to be developed that will stand up under the service condition and have a high endurance limit.

Manganese steels are usually used for sucker rods. Considering all factors, these are about the most economical and serviceable materials available at present. Alloy steels resistant to corrosion and hydrogen sulphide embrittlement have not been tried out extensively because of their high cost. In the case of wire cables used in place of sucker rods, galvanized and copper-coated wires have given almost complete protection against hydrogen sulphide embrittlement.

In the accompanying illustration is shown a section view of a pump consisting of barrel, plunger, standing valve, and traveling valve. Operation of the pump readily can be visualized from the illustration. The barrel is a heavy steel or cast-iron tube finished on the inside and its upper

EXAMPLE of corrosion effect on an oil-well casing





THIS entire pump assembly can be pulled out by the sucker rods

SPONTANEOUS rupturing under no load of high-carbon steel wires produced by exposure to hydrogen sulphide. Frequent lubrication will reduce such failures

CORROSION of sucker rods resulting from the increased stresses caused by reduction of rod area

end attached to the tubing. The cup packings on the steel piston are subjected to severe service. They must prevent leakage against pressures as high as 3,000 lb. per sq. in., and must work in a fluid that may contain a considerable amount of abrasive sand. Leather, rubber, and impregnated fabric are used.

The advantage of the type of pump shown is that it is not necessary to pull tubing and sucker rods to make repairs or replacements in the pump barrel, an expensive operation. There is also to be considered the loss in production during the period that the pump is out of service.

Most of the trouble with the valves, pistons, and barrels is caused by wear resulting from sand in the oil. Leakage past the worn valves or pistons greatly reduces the volumetric efficiency. Another cause of decreased volumetric efficiency is the gas liberated from the oil on the suction stroke and pocketing beneath the piston. On the down stroke this gas is compressed, a corresponding volume of oil failing to be forced through the traveling valve, thus decreasing the output of the pump.

Development work undertaken by many manufacturers and users of pumps has resulted in many improvements. Several manufacturers have developed a type of plunger pump in which the entire working parts of the pump can be pulled from the well without pulling the tubing. Much work has also been done in the development and selection of materials and design of valves and plungers to reduce wear and eliminate troubles from this source. Research work that will lead to further improvements are impelled by the ever increasing depth to which wells are being driven, a condition that makes more serious the present shortcomings of this type of pump and also definitely limits the field of its application.

The insert type of barrel, which permits the working barrel to be pulled with the sucker rods, is an example of one improvement. In this construction, the arrangement is made for pulling the standing valve also. Thus, all working parts of the pump may be pulled to the surface for inspection and replacement with a minimum of trouble and lost time.

Further developments are being tried out with special metals to reduce wear and corrosion. Barrels have been electroplated with chromium and other metals. Ball valves made of "stainless steel," brass, and copper-bearing steels have been tried. Alloy steels have also been used for barrels. These materials have been used for casings also; and in addition, wrought iron, brass, bronze, paints, and coatings, have been tried with varying degrees of success.

In fluid-actuated pumps oil is pumped down from the surface through a pipe to the underside of the piston while the oil above the piston is forced out through a second pipe leading to the surface. On the down stroke oil is forced behind an auxiliary piston or something equivalent thereto, and the actuating oil is pumped out, also through the second pipe leading to the surface. About three parts of oil under high pressure is pumped down, and about four parts of oil is discharged from the well, giving a net produc-

tion of one part per cycle. Properly designed, a relatively high theoretical efficiency is obtained.

A difficulty with this type of pump arises from the complicated type of valve that must be put in the small space at the bottom of the hole, where it is not readily accessible. Also the high operating pressures required, up to 5,000 or 6,000 lb. per sq.in., result in serious losses of oil through even only small leaks. Another disadvantage is the requirement of two strings of tubing, which adds to the initial cost and increases the trouble in pulling the tubing.

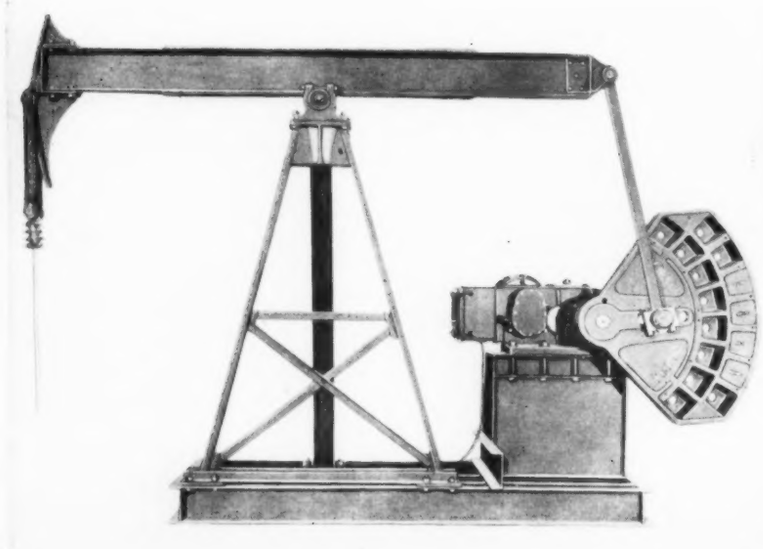
Air may be used for actuating this type of pump, the air being discharged into the casing instead of pumping it out through the discharge line. This reduces the velocity and friction head in the discharge line, thus reducing the pressure required. It is also possible to discharge the air into the discharge pipe, thus reducing the static head by the aeration of the oil column. A somewhat greater air pressure is required.

This type of air-actuated pump has most of the disadvantages of the oil-actuated type. In addition, it has a very slow delivery if the energy of expansion of the gas or air is used, while if it is not used the efficiency will be rather low. In any case, the theoretical efficiency will be lower than for the oil-actuated type since a large part of the energy put into the gas is used in compressing it. This type of fluid-actuated pump is in the process of development and shows possibilities of great improvement if the more troublesome faults can be remedied.

Although it has been used on a large scale in this country only since about 1925, the production of oil by the air or gas lift is not new. The air lift was used in the Russian fields in 1899 with considerable success. Where a sufficient quantity of natural gas is available, gas is used instead of air because air mixing with oil absorbs gasoline vapor and is mixed with natural gas set free from the oil. These explosive mixtures endanger equipment and the lives of operators. Further, because of the danger from explosions when using air, no attempt is made to condense the gasoline vapor after coming from the well, and large quantities of natural gasoline are wasted. Some operators report a lower quality of crude oil when operating with air because of the oxidizing effect of the air when intimately mixed with oil under pressure.

Some of the major advantages to be gained by the use of the air or gas lift are: greater capacity; continuity of operation since there are no working parts in the well; low maintenance cost; central plant operation; and the utilization of formation gas to aid in lifting the oil to the surface. In the case of a plunger pump, formation gas coming into the well with the oil is a detriment as it tends to "gas-lock" the pump, even small amounts of gas materially reducing the volumetric efficiency of a plunger pump. Some of the disadvantages of the air-gas lift are: cost of plant installation; the formation of emulsions when water is produced with the oil; increased corrosion of tubing and casing in the well when the well is producing hydrogen sulphide or when operating with air; paraffin trouble caused by the deposition of paraffin in parts subjected to cooling from the expansion of gas; and a low mechanical efficiency. The efficiency drops rapidly as the submergence decreases with the lowering depth of the well. This necessitates increased compressor capacity or using some type of plunger pump. However, mechanical efficiency is often of negligible importance in oil production compared with other factors. Production at the highest rate possible is of greatest importance, particularly under competitive production in oil fields that lie adjacent to one another.

When the fluid level has been lowered until it is no longer economical to produce by continuous gas lift,



UNIT DRIVE for oil pumps with reduction gears, motor and control combined into a single compact housing mounted on a common base with walking beam, pitman, and Sampson post. The counterbalance on the crank is adjustable by insertion of removable lead slugs

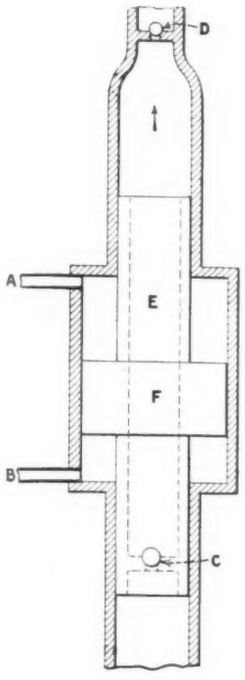


DIAGRAM showing the operation of a fluid actuated pump. Oil is pumped in at *B*, causing upward travel of piston *EF*. Valve *C* is closed; oil discharges through valve *D*. On down stroke, actuating oil enters at *A* and is exhausted at *B*; valve *C* opens and *D* closes.

Illustrations by courtesy of the Westinghouse Electric and Manufacturing Company, the Economy Pump and Oil Tool Company, and the Gulf Research Laboratory

the intermittent system of gas lift production is often employed. This consists simply of applying gas to the well for a short period and lifting a column of oil, often in the form of an unaerated slug, to the surface, and then shutting off the gas supply and allowing the pressure in the well to drop. This system allows a quantity of oil to flow into the well from the producing horizon during the period when the pressure is off; and it results in a much greater fluid level at the time that the well is flowed than could be maintained by continuous operation. As the efficiency of the lift depends largely on the submergence, this method generally shows a considerable increase in mechanical efficiency, and a decrease in gas consumption per barrel of oil produced. The daily production of the well is also frequently increased as oil will flow into the well much faster when the gas pressure is relieved than when held continuously against the sand face or other producing horizon.

For regulating the intermittent gas supply, automatically-timed pilot valves supply compressed air or gas to the diaphragm or piston of the main valve in the gas line. Several methods of timing the pilot valves are employed, including electric commutators and electromagnetically operated pilot valves, valves actuated and timed by a continuous water supply which trips the valve when a given weight of water has been supplied from a constant source, and pilot valves actuated entirely by compressed air or gas depending upon whichever may be used.

When it is undesirable to put any gas pressure whatever against the producing horizon, an intermittent gas lift having two concentric strings of tubing and a collecting chamber is used. The collecting chamber is on the lower end of the outer string and consists of one or more lengths of tubing of a diameter as large as can conveniently be lowered down the well casing. A check valve in the lower end of the collecting chamber admits oil from the well when the chamber is submerged. The inner string of tubing extends nearly to the bottom of the collecting chamber and serves as an eductor pipe for delivering a charge of oil to the surface when sufficient air or gas pressure is applied down the annular space between the two strings of tubing to the charge of oil in the collecting chamber. This method is necessarily slow when used in wells of considerable depth, because of the time required to relieve the pressure in the displacement chamber to a point where the static fluid head in the well will supply a new charge of oil. Also, because of the large volume of compressed gas that must be exhausted from the annular space in order to relieve the pressure in the displacement chamber, this method of pumping is very inefficient. Not only is the cost of pumping relatively high, but compressors of relatively large capacity are required, thus materially increasing the capital investment involved and also the cost of maintaining the larger equipment.

Several methods have been devised to overcome or minimize the losses incurred by the large volume of compressed air that must be exhausted from the annular space. One device utilizes a spring loaded valve at the upper end of the displacement chamber. This valve disconects the air or gas in the annulus from the displacement chamber when the pressure is only partially exhausted, and opens an auxiliary exhaust port which discharges the remaining gas from the displacement chamber.

Another method of overcoming the difficulty is to equip the displacement chamber with a valve actuated by a float in the displacement chamber. This valve admits gas automatically whenever the chamber is filled with fluid, and disconnects the gas supply and opens an exhaust port when the chamber is empty. This is the most desirable method, both from the standpoint of efficiency and speed of operation, but it is very difficult to devise a satisfactory valve because of the limited space available for a float and the adverse working conditions, or trouble from corrosion and sand.

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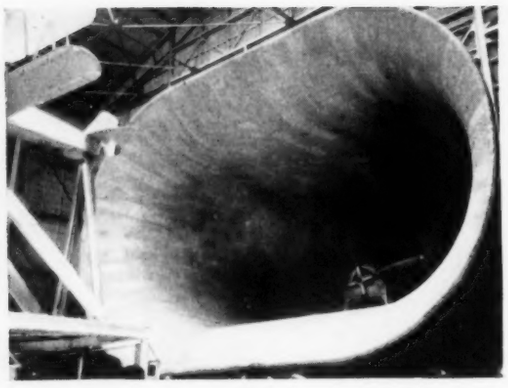
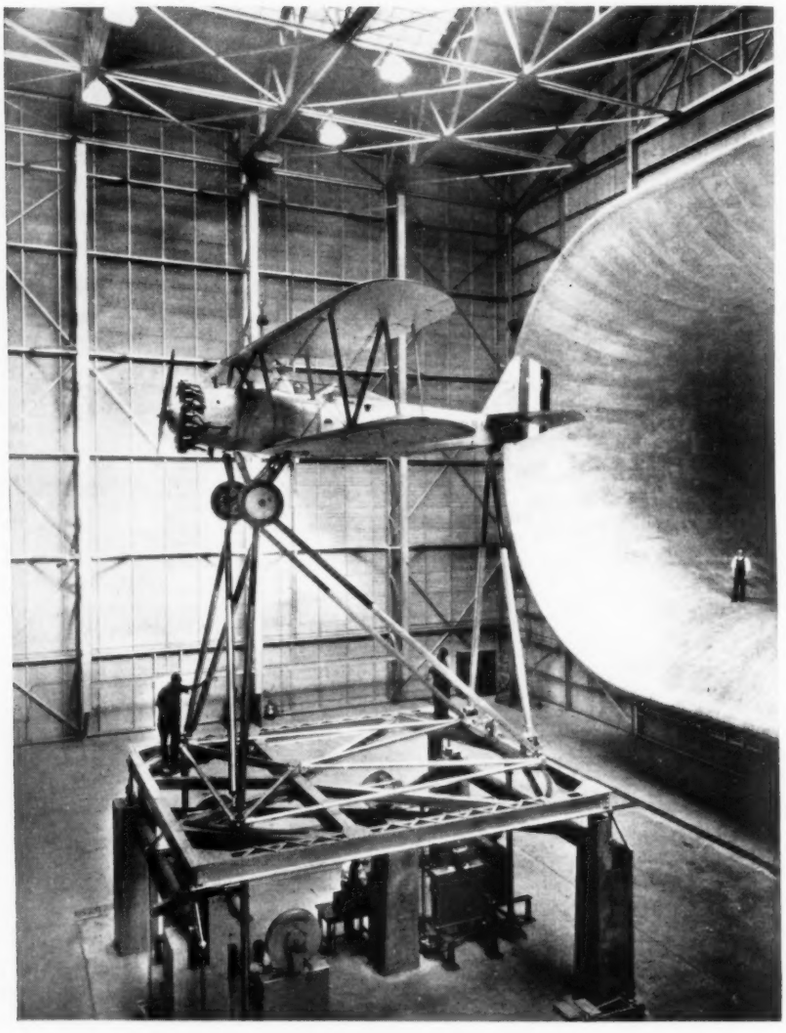




A VOUGHT CORSAIR mounted on the balance in the Langley Field wind tunnel and a view into the exit cone toward the twin 34-ft. propellers

Research Precedes development of High-Speed Vehicles

Interviews with
EDWARD P. WARNER
Editor, Aviation
and W. A. COULTER
Sikorsky Aviation Corporation

SPEED has become the watchword in the design of practically all transportation media. Essential in its attainment is the reduction of "drag" or fluid resistance. Such varied terms as "bullet," "teardrop," and the more familiar "streamline" are used to describe the radical drag-reducing innovations incorporated in the Zeppelin railcar, the streamlined locomotives of Westinghouse, General Electric, and others, the *Europa* and *Bremen,* the racing boats of Gar Wood, Major Seagrave, and other ship designers, the partially streamlined Reo *Flying Cloud,* Captain Malcolm Campbell's *Bluebird*—even some fast trucks, interurban cars, buses and barges.

These examples are drawn from fields of transportation other than aeronautical, fields ordinarily considered widely divorced from drag research. Aeronautical results of wind tunnel work have long been familiar, but now the same methods of research are being adopted in other vehicular fields. For that reason, it is essential that the vehicle or boat designer have some understanding of wind tunnels and towing basins, how they are built and operated and the work they are designed to perform.

Drag or wind resistance increases as the square

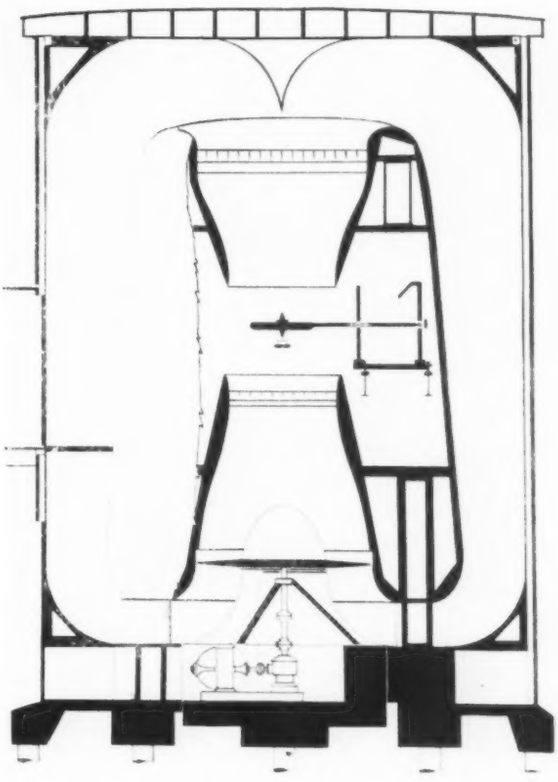
of the velocity, according to the drag formula:

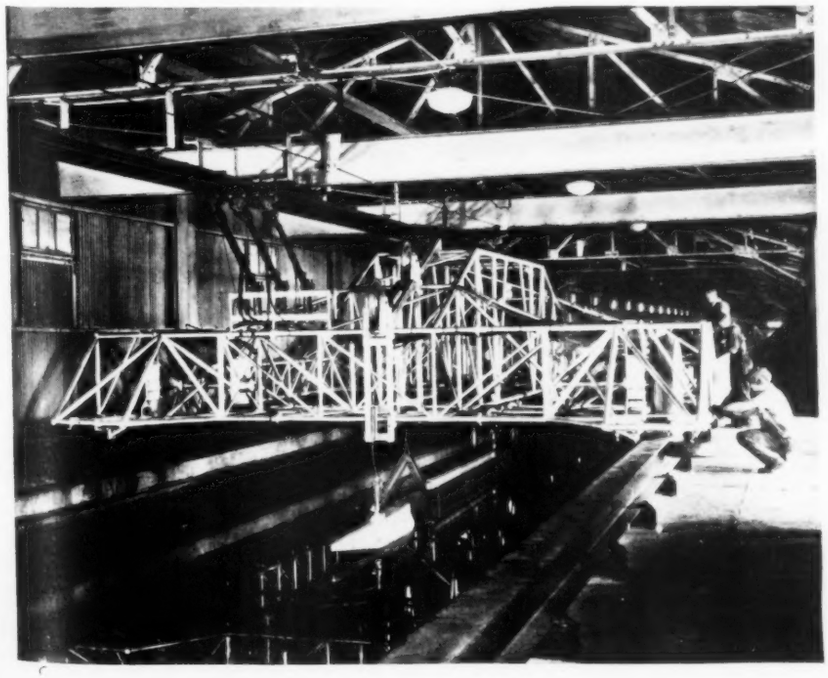
$$\text{Drag} = D_c\, SV^2$$

where D_c is the drag coefficient, S the projected area, and V the velocity. Since S and V are obviously constants for any given speed and size of vehicle, D_c must be reduced to reduce drag. Streamlining is of course the answer.

Performance data obtained from testing models introduces inaccuracies and inconveniences in design. To avoid this, the new $1,000,000 full-scale wind tunnel at Langley Field was built. Designed to accommodate airplanes of spans of 45 to 50 ft., the tunnel measures 60x30 ft. at the throat and will produce wind velocities up to 115 m.p.h. Its two 34-ft. 4-bladed propellers are each driven by a 75-294-r.p.m., 4,000-hp. electric motor supported in a streamlined nacelle in the slipstream and controlled in 24 equal steps. The propellers are arranged side by side, but deliver air into separate return passages. The two streams, after passing through several sets of collossal guide vanes, converge in a huge rectangular chamber behind the throat and are guided smoothly into the entrance cone. The same air is used over and over again, eliminating the need for great power which would be required to take air at zero velocity and get it to test speed.

The tunnel, 434½ ft. in length and 222 ft. in width, is of the open-throat type with the airplane under investigation supported in the airstream from below. Streamlined struts transfer the load to the balance platform. Angle of attack is controlled by a motor-driven adjustable strut under the tail and the angle of yaw is set by turning the

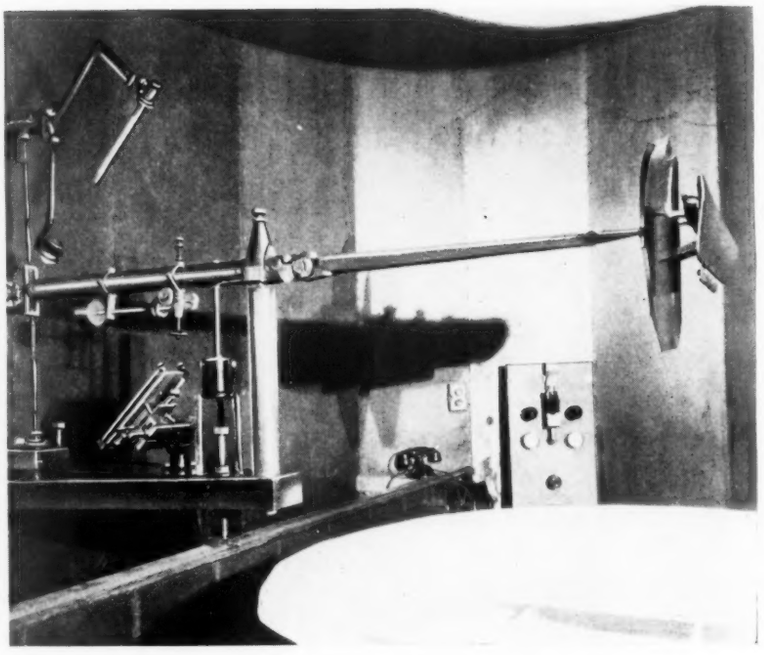




[TOP] Cross-section of the Sikorsky vertical wind tunnel, showing the arrangement of the 15-ft. experimental room within the outer shell. Airstream velocities of 65 m.p.h. may be attained and drag up to 65 lb. measured

[ABOVE] A covered passageway connects the Sikorsky tunnel directly with the engineering department. The tunnel building proper is 24 ft. in diameter and 32 ft. high, insulated by airspace and masonite. The two-part concrete foundation also minimizes vibration transfer

[LEFT] Ready to test a flying boat hull model in the Langley towing basin. The all-welded steel carriage construction and the pneumatic tires which support it are design features. These tires are inflated to 125 lb.; horizontal solid tires hold the carriage on the track



TESTING a model plane in the Sikorsky tunnel. The 50-in. uniform airstream, much larger than the usual 30-in. stream in tunnels of this size, permits testing of some full-sized parts

entire supporting system on the balance platform. Air forces are read directly from six Toledo scales. A unique arrangement permits simultaneous recording of all six readings from a single push-button station. The entire unit can be controlled and operated by two or three men, and it is predicted that polar determination work that would ordinarily require a month or more of continuous flight testing may be accomplished more accurately in the tunnel in two or three hours of testing work.

Distinctive design features of the Sikorsky tunnel, the idea of Prof. D. E. Olshevsky of Yale, are its vertical construction and high efficiency. Its advantages are more mechanical than aerodynamic. The airstream arrangement permits ease of access and observation from any side, since the observer can go all the way around the model and remain on the same floor level. Since the direction of the airstream is the same as that of gravity, any position around the airstream is identical in measuring balances. The entire arrangement is built symmetrical with its axis, resulting in uniform airflow and considerable saving in space.

Several features of note are incorporated. The air leaving the impeller passes radially through a set of symmetrical streamliners which diminish the rotational component of the wind velocity and also house the supporting members. Another radial honeycomb on top of the entrance cone consists of two independent layers of symmetrically streamlined blades, each adjustable to a specified angle as may be required.

The de Bothezat suction fan, driven by a wide-range 20-hp. Westinghouse d.c. motor, is so designed that a connecting passage permits oiling both motor and speed reducer while they are in motion. Current is supplied by a motor-generator set outside the building. Control of this set, the fan motor, and the lights is centralized on a switchboard in the experimental room, where are also available a.c. and d.c. currents, compressed air, gas, and water.

The towing basin at Langley Field also exhibits many engineering features. The channel proper, 24 ft. wide, and 12 ft. deep at the center, is built of reinforced concrete and is bridged by a towing carriage running on a pair of parallel H-beams. The carriage is operated by four electric motors, each geared to a driving wheel. Current for the motors is taken from overhead wires through suitable trolleys. Control of the carriage, except for emergency stops, is from a desk at one end of the channel. Two observers ride with the model.

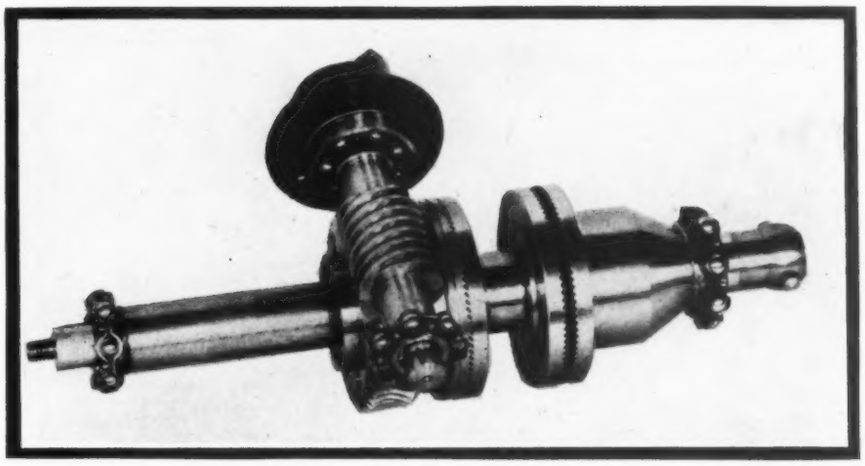
GENERAL view up the 2,040-ft. Langley towing basin. Models up to 10 ft. long may be tested at speeds as high as 50 m.p.h.

The unusual speed recording device incorporates a photo-electric cell which picks up flashes of light transmitted through a series of holes spaced on 5-ft. centers along a flat steel tape over the center of the channel. The tape travels continuously through the instrument as the carriage progresses along the tank, giving a complete record of distance versus time—hence speed.

Heavy Telescope Design

By HENRY SIMON

Extreme operating precision of heavy telescope masses largely depends upon careful design of the driving clock with its two elements, the clockwork proper, and an electric synchronizing control



ACCELERATOR or high-speed gear, an independent prime mover used to move the telescope rapidly to a new position

IN large telescopes, the gear train which imparts diurnal rotation to the instrument comprises the driving shaft linkage, a high-speed and reversing gear, a speed-varying gear, the driving clock, the driving clock control relay, and the astronomical clock, in that order.

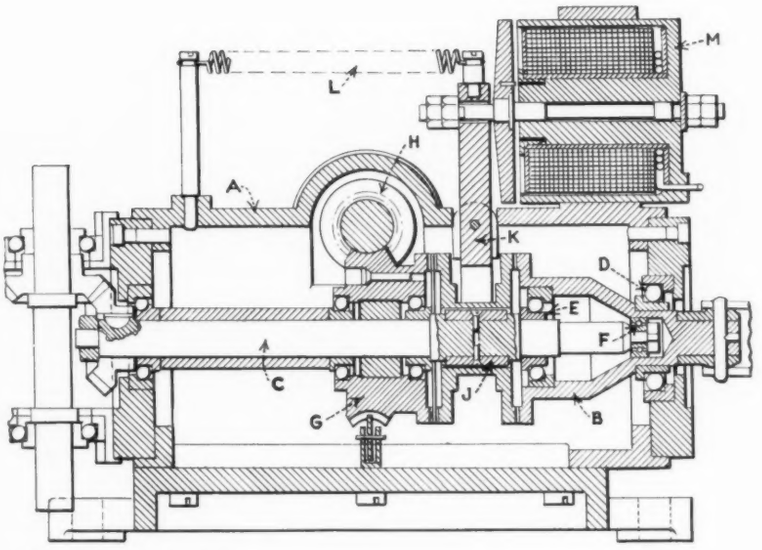
The driving linkage comprises worm and bevel gears of ordinary design and accuracy. Because of the large drop in speed between the main worm and the clockwork, the periodic errors of this intermediate gear train are "diluted" to the point of insignificance by the time the worm is reached. The heart of the entire train is the driving clock, which may be defined as a combination prime mover and precision chronometer. While thus timed with the extreme exactness of the astronomical pendulum, it becomes necessary at times to influence the speed of the driving clock arbitrarily, as when changes in the refraction of the atmosphere must be compensated for, or to speed up the driving gear train ahead of the clock in order to move the instrument rapidly to some new position. The means to these ends in the Zeiss telescopes are the accelerator, or high-speed gear, and the speed-varying or corrective gear.

The speed-varying gear, or "mouse" is designed to increase or decrease the speed of the telescope by a few per cent over a period anywhere from a fraction of a second to any number of minutes. This is accomplished by a composite shaft somewhat resembling an automobile rear axle, in which both the internal shaft and the housing are capable of revolution. With the housing at rest, the output speed is equal, though in the reverse direction, to the input speed. By rotating the housing over gears from one or the other oppositely revolving halves of the internal shaft, motion is subtracted or added to the latter, and its speed—and the speed of the drive, varied accordingly.

Modern telescope driving clocks embody two distinct elements, the clockwork proper, and an electric control for synchronizing the clockwork with the master pendulum. It is only by this combination that a mechanism is obtained which runs at the extreme precision of the astronomical clock while developing sufficient power to drive the heavy masses of the telescope. It should be understood, however, that the driving clock itself is a creditable timekeeper without the remote control. The control merely eliminates residual small discrepancies, and times the clock strictly with the astronomical pendulum.

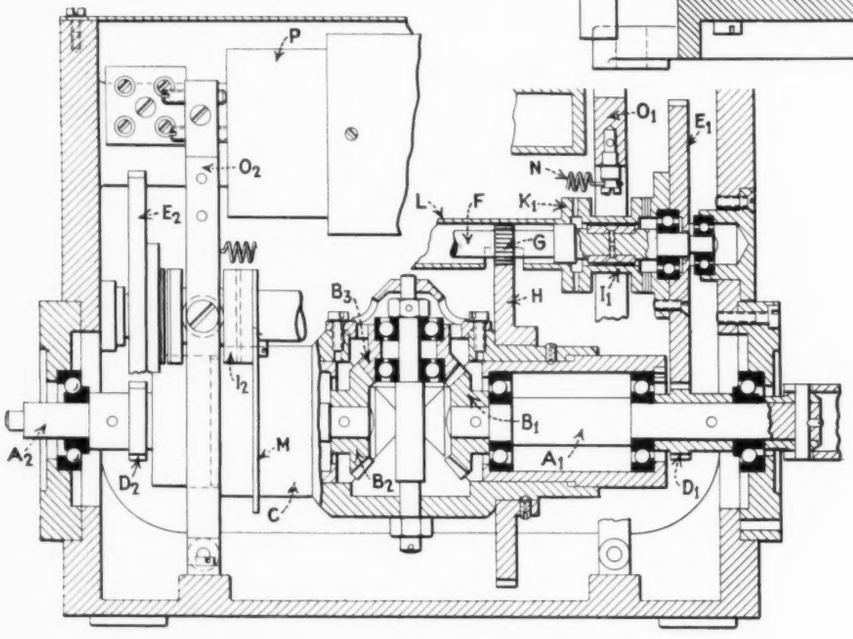
Driving clocks are of several different types, but resemble each other in that they obtain speed control by the radial shift of an eccentric poise. The latest Zeiss telescopes incorporate a direct-motor-driven clock of radically new design.

This clock may be said to consist of three main functional elements, housed in as many superimposed sections. The bottom section contains



HIGH-SPEED GEAR SECTION

[Right] Housing A carries one end of section B of divided shaft BC in ball bearing D, ball bearings E and F supporting B on C. Free to revolve on C is worm gear body G, driven when desired by worm H from the reversible motor. Connection between B and C, or B and G, is established by a 2-faced clutch body J slidable on C, and acted upon over lever K by spring L and electro-magnet M. Normally, spring action keeps the motor at rest, but energizing motor and magnet cuts off C from B, connects B and G, and revolves the telescope at a rate of once in 2.4 hr.



SPEED-VARYING GEAR SECTION

[Left] Main shaft halves A_1, A_2 are connected by planetary gearset $B_1B_3B_2$ in shaft housing C. Pinions D_1D_2 on shaft sections A_1A_2 transmit motion to spur gears E_1E_2, normally idling on backshaft F, which by pinion G engages large spur gear H fast on the housing. When F and C are at rest, the shaft assembly revolves at clock speed; when they are in motion the variation in speed reacts at output end A_2. Clutches I_1I_2 bring this about. Clutch body I_1 is slidable on F and engages either gear E or serrated flanges K_1 on sleeve L, held against rotation by a fork riding on C. By energizing one side or the other of magnet P, either gear E_1 or E_2 is connected with F causing C to revolve.

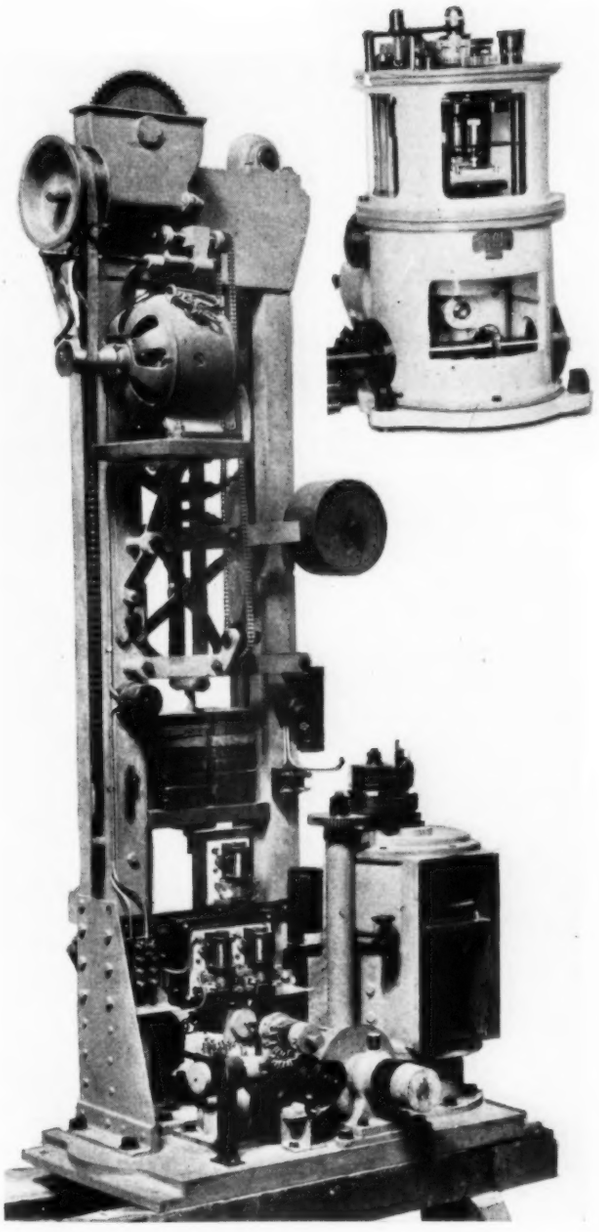
the motor and reduction gear by which the governing device or "regulator" is energized, and from which the telescope is driven. The center section accommodates the regulator. This is the heart of the mechanism and corresponds to the pendulum and escapement of an ordinary clock. The top bears the parts of the remote control mechanism by which the regulator is synchronized with the astronomical pendulum.

The drive actuates two separate shafts in the clock mechanism, one shaft for spinning the regulator at a speed of 300 r.p.m., and a second shaft by which the time control on the top section is revolved at 30 r.p.m. These shafts in turn are connected by gearing with the output shaft to the telescope. A somewhat unusual detail is a heating element provided on the hand hole cover on the base for warming the circulating lubricating oil and maintaining its viscosity in cold weather.

The regulator differs from the illustrated schematic arrangement in various ways, though in no fundamental respect. Instead of one leaf spring, a pair of springs are used. It will be noted that they are pinned to a fixed knife edge at one end and to a rockable double-bladed knife edge at the other, while in the middle they are similarly secured to knife edges by which they are held depressed by a bell-crank lever. By this arrangement their bending moment remains practically unaffected by any element of friction, as well as by the change in effective length which would result with fixed supports as the springs change their curvature under varying pressure.

The bell-crank lever is of composite design, comprising a hollow main body and a tongue which bears the contact point. A noteworthy departure is in the design of its fulcrum. This is not a pivot, but a foil spring clamped between two pairs of plates similar to a clock pendulum hinge, though closely held. It may be useful to point out that this is the one device which combines minimum initial resistance with positive assurance that this resistance will never vary appreciably.

The eccentric weight is suspended from one of



DRIVING CLOCKS—OLD AND NEW

Size-for-size comparison of the former weight-operated driving clock and the modern electrical one. At right is the drive section of the new clock, showing the 110-volt d.c. motor with field resistance capable of causing a 30-volt drop and a corresponding 400-r.p.m. speed rise. By a high-frequency succession of makes and breaks in field circuit resistance, the motor is maintained at 2,400 r.p.m., the drive shaft speed required to revolve the telescope once in 24 hours.

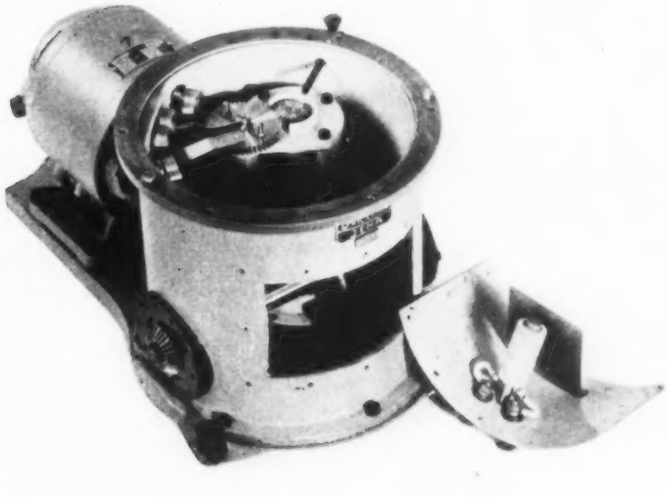
the four posts used in a frame in which the fixed contact point is mounted on the opposite side. At the speed of 300 r.p.m. of the regulator, the weight exerts a radial pull of approximately 3 lb. This weight furnishes an interesting example of free suspension obtained with the help of three foil springs placed at right angles to each other.

The clock synchronizing means may be said to consist of a mechanism designed to produce a continuous overspeed tendency in the regulator, and an electromagnetic latch periodically operated from the astronomical clock to return this speed to below normal. In thus, as it were, periodically eliminating the speed gain, the control locks the regulator exactly in step with the master pendulum.

During every second, there is a gradual descending motion of the remote control nut, followed by a quick return to its first position. This motion is translated through the lever system of the upper regulator section into a small alternating increase in the tension of the governor control springs, and a corresponding very slight speeding up or slowing down of the governor.

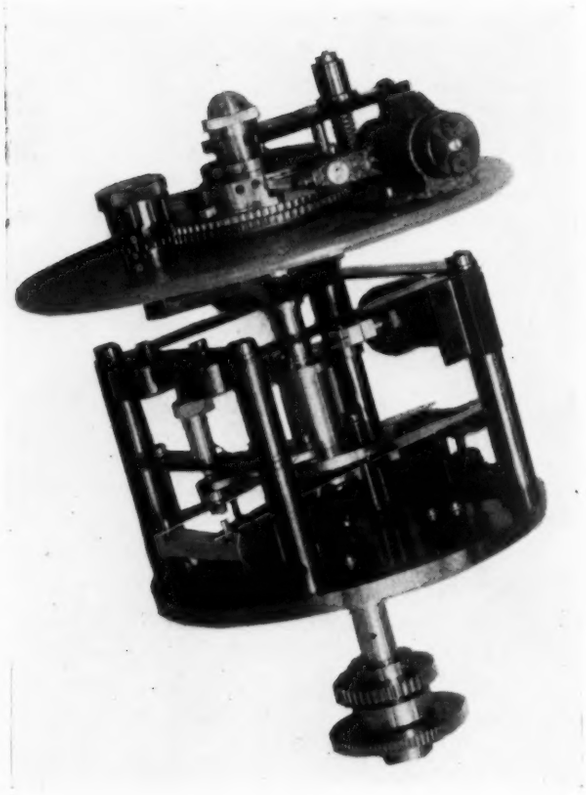
To understand the timing action, it should be borne in mind that the central shaft is positively geared to the regulator, and that the driving clock must therefore run at the right speed whenever the shaft is, or at one revolution every two seconds. Any slower speed of the shaft would cause the dog to be arrested later by the latch. This would cause the stud to make less than its one-hundredth turn, and therefore prevent the control nut from fully ascending. This is equivalent to an additional increase in the tension of the control springs, and to a consequent speeding up of the regulator.

Any increase in the speed of the central shaft over one revolution in two seconds would bring



about the reverse of the process, causing the control nut to rise above its normal limit, and thereby slowing down the shaft, and hence the regulator, to its normal speed. While there is, therefore, an extremely small "pulsation" regularly during each 2-sec. interval, any slight departure up or down from the average speed of one revolution in 2 sec. is corrected during the next revolution.

A more intensified action on this order takes place when, upon being first cut in, the driving



clock is still out of step with the control, and the dog is therefore out of range of the latch. In that case, the unchecked forward creep of the clutch ring continually screws down the control nut, thereby rapidly raising the speed of the regulator until the dog is brought within range of the latch. From that moment, the nut is rapidly screwed up during each successive revolution until the clock and control are in exact step with each other.

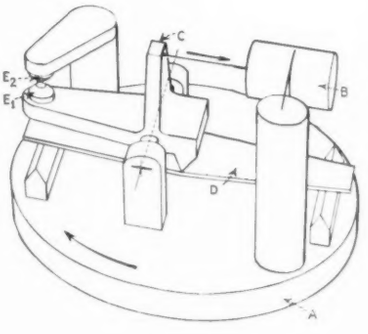
The actual design of the control mechanism differs from the schematic order in no important detail. The stud and nut are each made with a flange for protection of the parts underneath. The slot engagement for the transmission lever in the nut is replaced by a ball bearing, with the upper race of which the lever makes contact by two pins in its forked ends, and to which the lever is held down by a spring. Finally, limit stops are provided on the nut to release the clutch ring and prevent the nut from ever overrunning, as might otherwise happen, particularly in starting.

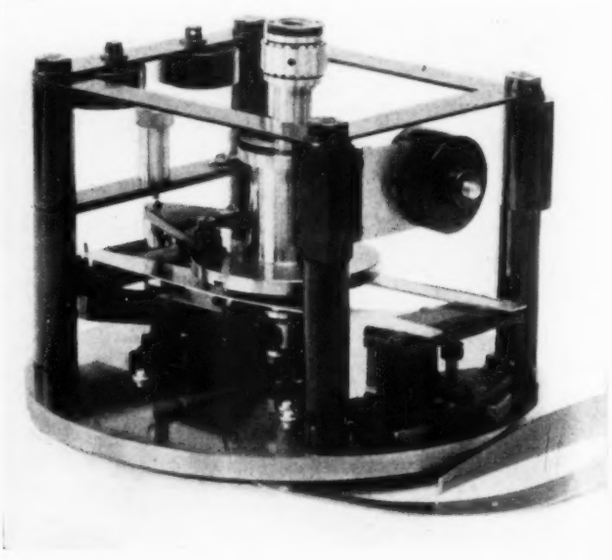
The final link in the train of mechanism between the telescope and the astronomical clock is the relay, which lengthens the almost instantaneous contact of the clock into a sustained "dwell" of the control latch magnet. This relay operates by causing the quick filling of a small air cylinder by the suction stroke of a piston during the momentary closing of the clock circuit, followed by the gradual escape of the air, during which the piston in slowly descending closes the control latch circuit throughout a part of a second.

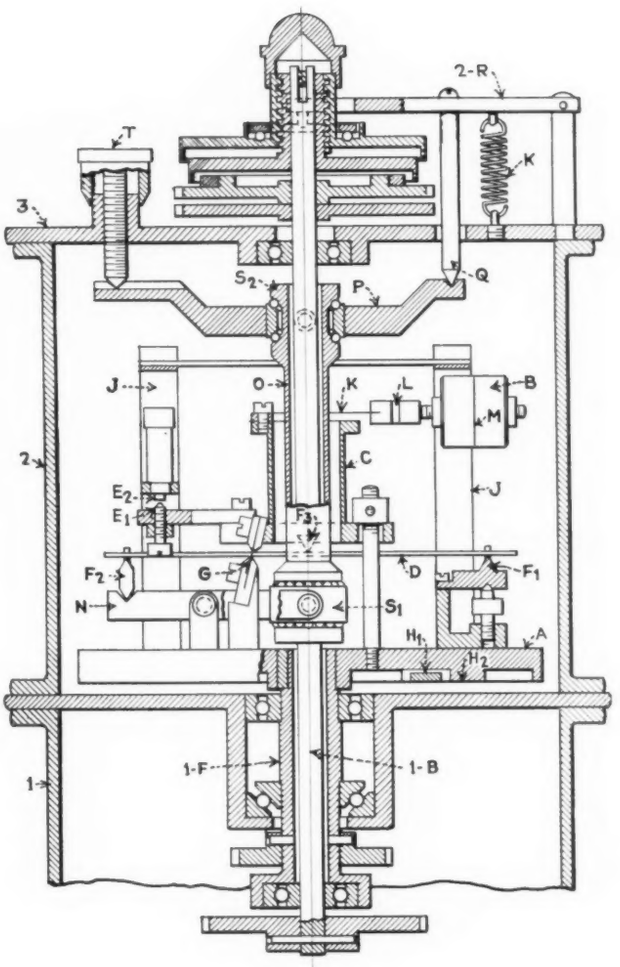
Actually, three different circuits are employed. Of these, one actuates a magnet from the regulator by means of a weak current at each stroke of the astronomical pendulum. The action of this magnet brings a lever against a contact point, thereby closing a heavier circuit and energizing another magnet. The attraction of this magnet, through a linkage, imparts a stroke to the piston of the air cylinder, drawing in air through a large-capacity valve in the cylinder bottom. At the same time, by lifting a slender leaf spring fast on the exposed end of the piston off-contact points it interrupts the regulator control circuit. In the subsequent descent of the piston, which is effected by a spring in the second magnet, the air slowly escapes through an exhaust valve. The regulator control circuit is established when the piston has sunk about two-thirds of the way down, and is sustained throughout the remaining period before the next clock impulse, thus bring-

REGULATOR AND CONTROL

A schematic representation of the regulator, and two views of it, the upper showing the remote control mechanism. A train of four elements determines speed of revolution: revolving base A, eccentric weight B, carried around by A and capable of slight radial movement, double bell-crank lever C rockable on a fulcrum on A by the pull of B, and leaf spring D, acted upon by the inner end of lever C. The outer end of C carries contact E_1 in a circuit which when closed shorts motor field resistance and slows the motor. This causes centrifugal force on weight B to lessen, B returns to position, and the motor speeds up again to complete the cycle.





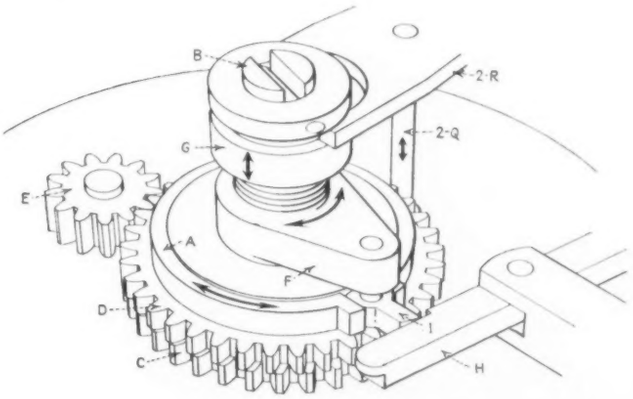


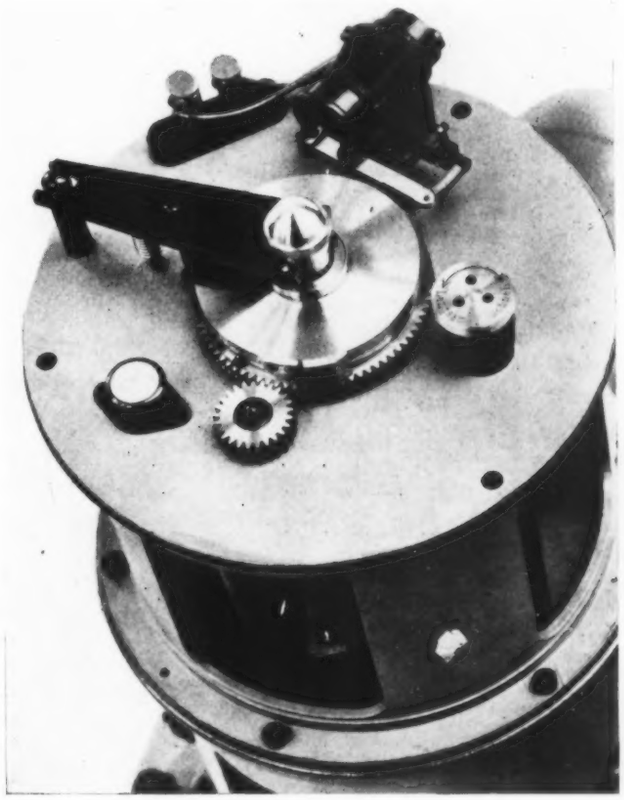
REMOTE CONTROL ELEMENTS

Shaft *B*, geared to the driving mechanism, is revolved once in 2 sec. Clutch ring *A* is given continuous overspeed relative to *B* by gear combination *CDE*. As 100-tooth *C* makes one revolution in 2 sec., 99-tooth gear *C* makes $\frac{100}{99}$, or practically $1\frac{1}{100}$ revolution. This screws stud *F* into nut *G* 1/100 turn and causes *G* to descend slightly. Electromagnetic latch *H*, actuated $\frac{1}{2}$ sec. each 2 sec. by the astronomical clock, brings about opposite motion. Dog *I* collides with *H*, releases, and arrests *A*, causing *D* to move ahead of it through latch "dwell." At right is the control.

REGULATOR SECTION

[Left] The spring tensioning transmission consists of lever *N* pivoted on base *A* and carrying free knife edge F_2 at its outer end and transfer system *OPQR* through which the remote control mechanism acts upon regulator springs *D*. Hollow rod *O* is pivoted relative to *N* and *P* in the outer races of ball bearing S_1S_2 to enable it to effect transmission from revolving system *A-N* to stationary system *PQR* on the regulator gage. Horizontal lever *P* is held under constant minimum tension against springs *D* by micrometer screw *T* at one end and the last link of train *RQP* at the other. The train transmits spring tension varying motion from the remote control mechanism.





ing about the dwelling action of the driving clock control latch.

It is interesting to note in the design of the various mechanisms that, in spite of their utter dissimilarity of function and purpose from those of machine tools, the same modern tendencies are in evidence. One of these is the application of electric remote-control, and especially of individual motor drive. The new type of driving clock is evidently altogether inconceivable without the direct use of the electric motor. Again, the employment of a motor in the high-speed gear makes a cleancut unit that for simplicity and convenience of control could not be duplicated in any central-drive plant.

Worthy of attention is the almost general employment of standard ball bearings. Not so many years ago, ball bearings were restricted to points exposed to hard and continuous wear. Ball bearings take the thrust of the heavy telescope parts and guide them accurately, and are also used throughout the three drive mechanisms.

This is the second and last of two articles by Mr. Simon, based on interviews with Dr. F. Meyer, chief engineer of the Zeiss Optical Works, Jena, Germany.

Constant-Displacement Pumps for Machine Actuation

Gear pumps are treated in detail in this article, the second of a series on hydraulic control. Vane, centrifugal and reciprocating types will be taken up in subsequent articles

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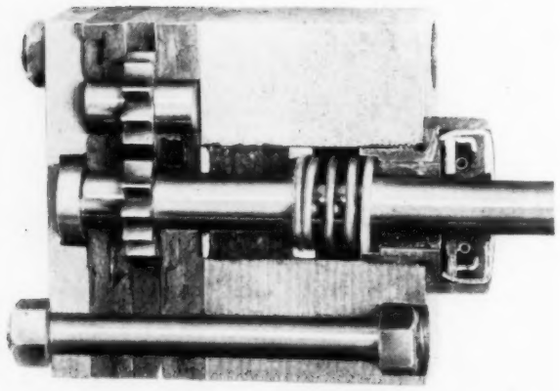


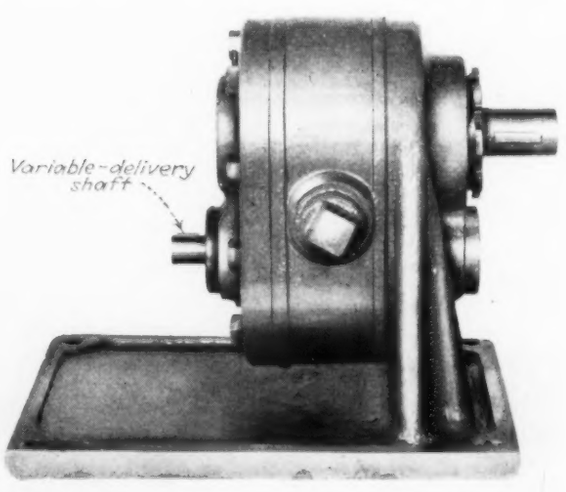
NORTHERN pump for pressure to 1,000 lb. per sq.in. All wearing parts are Nitralloy steel

CONSIDERABLE variety of pumps having a constant-volume delivery under constant speed and pressure conditions is available for actuating hydraulic equipment. Some of these pumps are simple rotary types; others are more complex. All are of simpler construction and lower in cost than the variable-stroke plunger pumps described in the first article of this series. On the other hand, the application of the constant-displacement type often requires supplementary equipment such as accumulators or unloading and relief valves, that can be avoided, as a rule, where a variable-displacement pump is employed. Sometimes a lower efficiency is involved, but this is of minor importance where the power consumption is small. Where the function to be performed is simple, the relative cost of the two systems is often a determining factor.

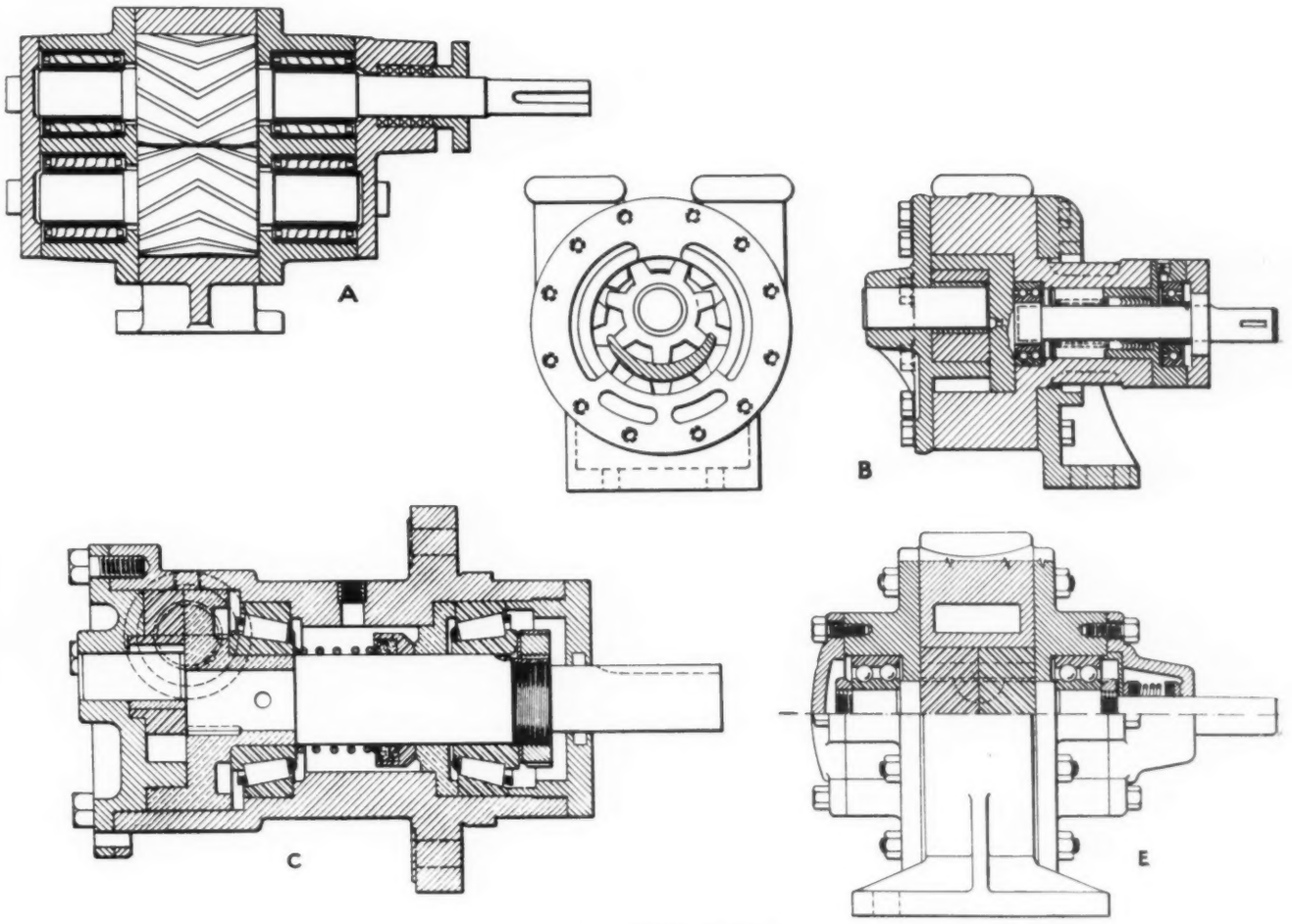
So-called constant-displacement pumps, that is, pumps that deliver a substantially constant volume of fluid when run at a constant speed under a given head and do not have a variable stroke, include the following types: (1) Gear pumps, (2) Vane pumps, (3) Centrifugal pumps, (4) Reciprocating plunger pumps.

Gear pumps are used extensively for actuating machines hydraulically, generally where accurate speed control is not essential and the pressure required is not high. Pumps of this type capable of pressures up to 1,000 lb. per sq.in. are made, but the average pressure is 300 lb. Especially where high fluid pressures are required, extremely close fits are necessary at the ends of the gears and between gear teeth if slippage losses are to be kept low. Center distances also must be held within close limits, and to accomplish this, wear must be minimized. Consequently, anti-friction bearings generally are considered essential.

In most gear pumps, slip increases also as the



INPUT to the Barnes variable-delivery gear pump is by the shaft at the right. Turning the left-hand shaft varies the delivery



Cross-Sections of Gear Pumps

A, Worthington with herringbone gears and Hyatt type bearings, max. pressure 105 lb. per sq.in.;

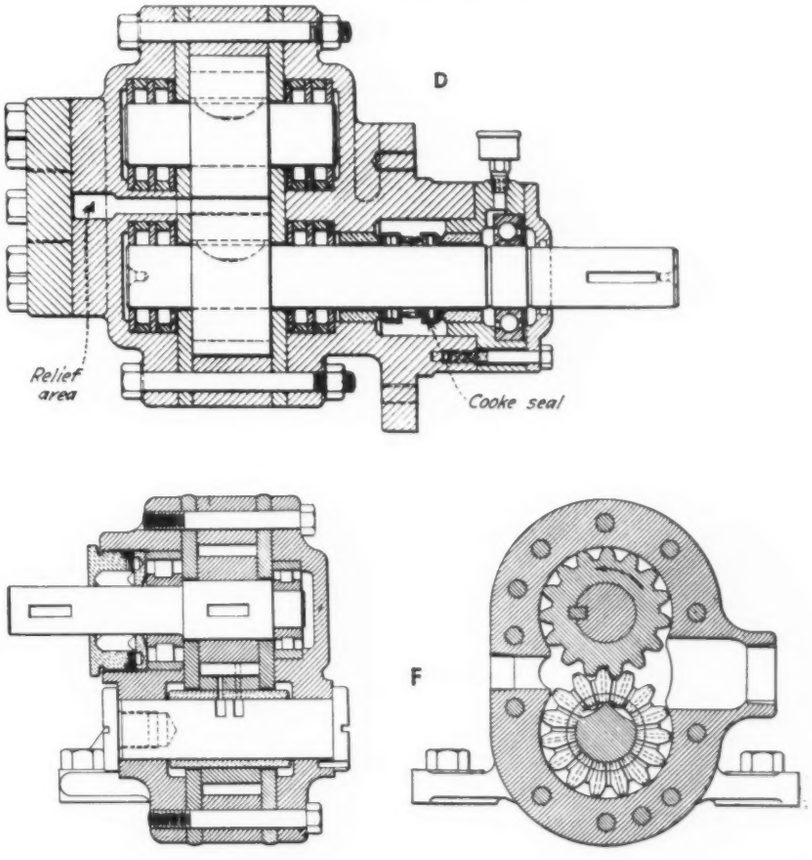
B, Tuthill Model CP with ball bearings and internal-external gears, max. pressure 300 lb. per sq.in.;

C, Viking with taper roller bearings and internal-external gears, max. pressure up to 500 lb. per sq.in.;

D, Tuthill spur-gear type with double-row cylindrical roller bearings, designed for 1,000 lb. per sq.in. pressure;

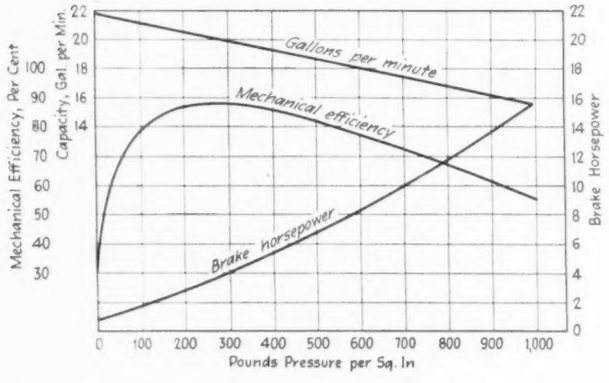
E, Roper 911 Series herringbone gear pump, 300 lb. per sq.in. pressure;

F, Barnes gear pump. ordinarily used for constant delivery, but subject to variations in output from 1 to 8 at pressures to 1,500 lb. per sq.in. Some features are wide angle teeth, radial relief passages in the teeth of the idler gear, and its support on a Nitralloy arbor, which also combines the control valve.



viscosity of the liquid pumped decreases and also as the discharge pressures increase. Slip results in lower volumetric and mechanical efficiency and also in the generation of heat. As the temperature rises, the viscosity falls, and losses through slippage become greater. With pressures around 100 lb. per sq.in. the delivery capacity of a small geared pump on test dropped 10 per cent between 70 and 120 deg. F. At 600 lb., on the other hand, the volumetric efficiency dropped 63 per cent by the time the oil reached a temperature of 100. Larger pumps show smaller losses, but the figures indicate the necessity of maintaining a cool oil.

Besides the pump itself, the principal sources of heat are the throttle valve, the relief valve, and



CAPACITY and power curves of the Roper No. 3 herringbone gear pump handling engine oil of 350 Saybolt seconds at 92 deg. F.

operating valve. Constricted piping with sharp bends or piping of too small diameter for the volume being passed are other sources of heat. In a system employing a throttle valve, generation of heat is inherent and this practically limits the amount of flexibility or throttling available in these constant-volume systems. Relief valve losses can be minimized by the use of an unloading valve, with a low-pressure bypass. In a four-way control valve, for example, there can be a neutral position allowing the fluid to be recirculated back through the pump against only the resistance of pipe line friction. On the other side of the valve, fluid is locked in the system under pressure. Not every hydraulic system, however, is susceptible to this arrangement.

By proper design, the reservoir may be made a source of heat radiation. Proper baffling of the reservoir prevents excessive churning, with consequent aeration. Air in the system will often make it inoperative. If the stream is directed horizontally against a vertical baffle plate, the flow is dissipated with less agitation than if it were dropped vertically into the sump.

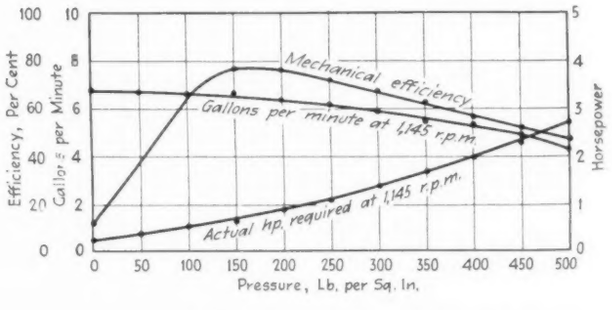
Consideration should also be given to the probable location of the equipment. In extremely exposed positions, for example, on a snow plow bulldozer, some provision may have to be made to heat the oil to keep the viscosity within the working range.

The question of duty is important. Continuous operation introduces factors that are not present in infrequent operation. Where the work load is intermittent, but where the pump must be operated continuously so as to be ready to accept the load when applied, the problem is to keep down the losses while idling. A neutral position of the control valve is one solution.

Satisfactory performance with wide speed variation of the driving means is difficult to attain with a constant-displacement pump because of its inherent limitations. Excessive throttling results in heating, causing a variation in the viscosity of the oil, which besides reducing the volumetric efficiency, affects the volume passed through the throttle. In many applications the exact speed of the action is immaterial.

Gear pumps are compact and have the advantage of simplicity, besides moderate first cost. They have, as a rule, only two moving parts; namely, the gears themselves. Practically, the pressure is uniform and continuous; the flow non-pulsating. The pumps lend themselves to fairly high rotative speeds. Their over-all efficiency curve usually rises to a maximum, then decreases as the pressure head increases, and averages 60 per cent. The higher figure is exceeded, however, in those pumps where anti-friction bearings are used and extreme care is exercised in machining and fitting gears and other parts.

Plain spur gears frequently are employed in gear pumps, but other forms are more generally selected when quiet operation is desired at high pressures and high speeds. Helical gears tend to reduce any pulsation in flow and to promote



PERFORMANCE curves of a Viking 5 g.p.m. pump. Paraffin oil of 200 Saybolt seconds was used, the test temperature being 115 deg. F. With a larger pump, the efficiency is improved

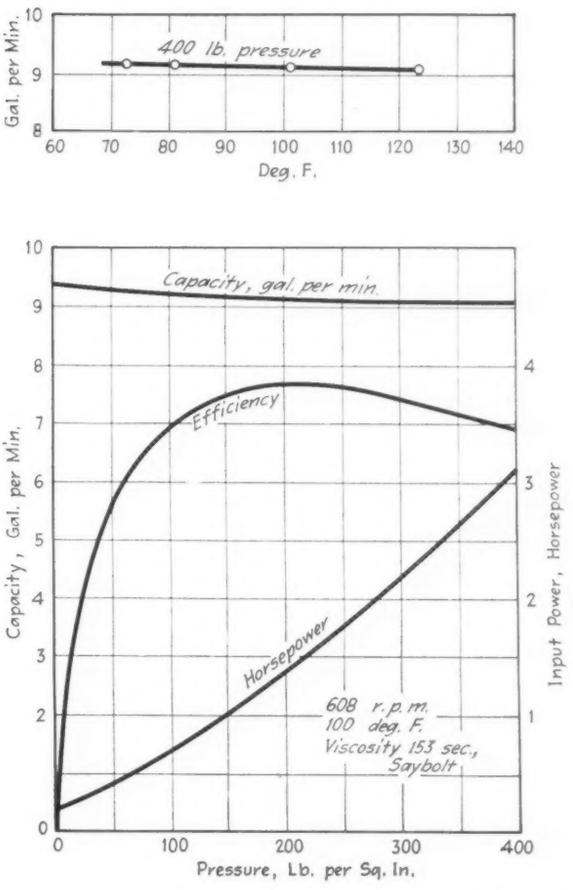
greater quietness in operation, but end thrust must be provided for. For the same reasons, herringbone gears are often used, and the end thrust of one-half of the gear is balanced against that of the other half. In fact, the gears actually float upon each other without axial restraint.

The Roper high-pressure gear pump employs continuous-tooth herringbone gears of special tooth profile to eliminate end thrust, increase hydraulic and mechanical efficiency, reduce slippage to a minimum, and insure quietness of operation. The pumping elements or gears are mounted on precision double-row ball bearings to obtain accurate and permanent alignment. Pressure lubrication is applied to the bearings. The internal passages are arranged to preclude trapping and to keep suction and discharge velocities well under the safe operating limits. A wide variety of flange mountings are available. Pumps of this type develop pressures up to 1,000 lb. per sq.in.

Noise and heat in a gear pump may be caused by trapping of oil at the bottom of the teeth in the meshed position, and to overcome this it is customary to provide relief ports in the housing at each side of the gears at the point where they mesh. The ports result in more rapid filling and discharging of the spaces between the teeth and casing. Modified tooth forms also have been developed to overcome this trapping. It is considered good practice to make one gear of steel and the other of bronze, where quiet operation is essential. Slip is reduced and efficiency is promoted by providing close running fits between the teeth as well as between gears and casing. Center distances, side clearances, tooth bottoming clearances and backlash are all held within close limits, and the design is made such that the gear axes will be parallel.

Another form of gearing is employed in one of the Tuthill pumps illustrated, as well as in the Viking hydraulic pump. In this case the driven member is an internal ring gear, the teeth of which are cut on the end of a flange overhung on the drive shaft. Meshing with this internal ring gear is a spur idler, the center of which is eccentric to the ring gear. This leaves a crescent-shaped space between the ring gear and the idler, a part of which is filled with a close-fitting member, which acts as a seal. In some forms of this pump the crescent "floats," and when the direction of rotation is reversed, the idler and crescent member move round through 180 deg., so that the direction of flow continues as before.

The Tuthill pump may be provided with an L-shaped flanged bracket having a foot which can



PERFORMANCE curves of the Barnes gear pump from test data at Cornell University

be turned in either direction to facilitate mounting, or it can be mounted on a bracket extending from the frame of the electric motor used to drive it. Some pumps of this type are provided with ball bearings between which a cup-leather packing is inserted. Such pumps are made for pressures up to 500 lb. per sq.in. Other Tuthill pumps, designed for 1,000-lb. pressure, employ a pair of conventional spur gears, each of which is mounted on a pair of double-row cylindrical roller bearings.

The Roots type pump is suitable for low pressure, about 5 to 80 lb. per sq.in. It employs a pair of two-lobe or two-tooth gears, which must necessarily have a pair of pilot gears for drive. Such pumps are said to be capable of 75 to 85 per cent efficiency. Their discharge is continuous, but pulsating.

An entirely new form of spur gear pump is the Barnes pump. Ordinarily the pump is set to deliver a fixed volume at any given speed and pressure, but it is possible to get a variation in delivery from 8 to 1 by mutual control. A typical performance curve illustrated indicates a falling off in delivery volume of only 2.8 per cent through the range of pressures.

In the cross-section, the upper gear is the

driven one and the lower gear revolves freely on a fixed journal, which also functions as a delivery control valve. A short tooth form with high pressure angle is used, giving a 3-point contact with clearance between the root and tip so small as practically to amount to tooth bottoming. With a single tooth contacting on both sides, the effect is of a plunger seal between tooth faces. Means must be provided for relieving the fluid. Also because the forward tooth of the driver is contacting the flank of the next driven tooth, a suction pocket is created which must be relieved by passage to the intake chamber before the tooth clears into that chamber. Radially drilled relief ports in the top and bottom of the idler gear perform this function. Proper distribution to the intake and outlet sides is afforded by sectors milled in the fixed journal.

When the journal is rotated clockwise, a part of the high-pressure oil is bypassed into the intake side. In this way, the discharge volume can be controlled within close limits. Tests have shown that even with a pressure of 1,500 lb. per sq.in., the oil temperature does not rise above 140 deg. F., which temperature is not considered to be excessive.

Unlike most gear pumps, the gears themselves are of air-furnace cast iron and are lapped to a running fit. They are also lapped into the pump body, which is of the same material. The bronze bushing which is pressed into the lower gear rotates on a Nitralloy journal, and with hydrostatic pressure in the tooth pockets offsetting the mechanical driving force, there is practically no wear in this journal. A lapped fit between the two adds to the rigidity and minimizes deflection. By pressing the cylindrical roller bearings in the housings, a radial preload is obtained which eliminates further internal deformation under load and prevents rubbing between the gear and housing.

The particular form illustrated is used mostly for hydraulic transmission, and is varied slightly when used as a high-pressure lubricating pump. In one form used for reciprocating a grinder table the lower journal is extended and a handwheel keyed to it for manual control of the delivery. The pump is designed primarily to supply the rapid traverse function in conjunction with a high-pressure variable-delivery pump. For this class of service its chief qualification is absence of aeration which might disturb the action of the variable-delivery pump. Because of its constant delivery and absence of slip it is feasible to use this pump to actuate fluid motors.

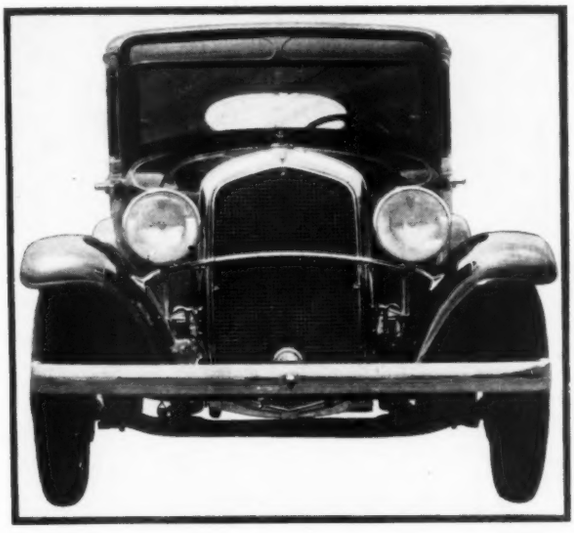
Although most gear pumps involve a certain amount of slip, especially at high pressure, they usually are classed as positive pumps. If the pump is driven at a constant speed, as by a motor, it is necessary in order to avoid abnormal pressure rise: (1) to proportion the delivery to the requirements of the machine operated or, (2) to provide a relief valve or accumulator to take care of excess oil, or (3) to unload the pump when its discharge exceeds the demand. Of course, it is always possible to vary the motor speed, either by electrical controls or through mechanical variable-speed units, and this method is becoming more common. A great variety of systems have been devised for making constant-volume pumps of the gear as well as of other types meet a fluctuating demand. A few of these systems will be described in a later article.

It is quite feasible to use two or more gear pumps of different size in combination. The larger one delivers a fairly large volume of oil at comparatively low pressure, as for the rapid traverse of a part not under load, and the smaller pump delivers oil in decreased volume at higher pressure for the work stroke. Necessarily, the number of control and relief valves is increased.

Successful operation of a gear pump is contingent to a large extent upon the proper selection of the valves. One of the chief objections to the conventional needle valve is that the volume passed with any given opening is proportional to the pressure, assuming the viscosity to remain constant. The Conradson Hydro-Jet speed control, is designed to overcome this. It is intended to throttle the discharge from a work cylinder. It combines a spring-loaded poppet valve that maintains a constant pressure on the high side of a needle valve, despite changes in pressure on the back side of the piston caused by variations in work reaction.

Gear pumps, because they are compact, light in weight and simple in design, are used often on portable or self-moving machines such as snow plows; so-called "bulldozers" used for grading and similar work; lift trucks; dump trucks; and the like. Other applications include sluice gate lifts; automobile lifts, such as are used in service stations; many forms of machines in which heavy pressures are required, as in presses and die-casting machines; and a variety of machine tools. Each case requires separate consideration of particular requirements, and not until all conditions to be met are known, is it possible to say which type and arrangement of pump will prove most satisfactory for the given conditions.

Plymouth's Floating Powerplant



"Floating power" is the most important innovation in the Plymouth automobile, but it is only one of several improvements designed to put this car in a better position in the lowest-price-car field. Buyers in this price class apparently are less interested in cylinder multiplication than in comfortable performance and the economy that a simple but powerful engine makes possible

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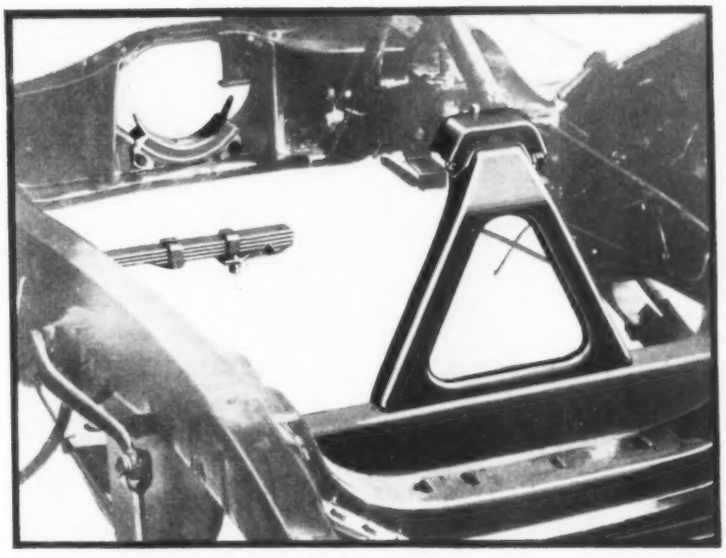
By HERBERT CHASE

WHEN in direct competition with large producers in the industry, a company cannot afford to add much to the manufacturing cost of its product. It is desirable, however, to incorporate differences in design which the user can definitely feel or experience. This, in the Plymouth design, was accomplished primarily by a new two-point suspension engine mounting and free-wheeling.

While making mechanical improvements the equally important factor of improved appearance has not been overlooked. A new double-drop frame permits decreased over-all height and the 19-in. enameled wire wheels add to the desired low effect. Pleasing body lines and a lustrous nitro-cellulose finish add materially to sales appeal. Hood, fenders and wheels are Bonderized before finishing to insure rust resistance and better adherence of finishing coats. There is also the usual chromium-plated bright-work, and many parts less exposed are cadmium plated.

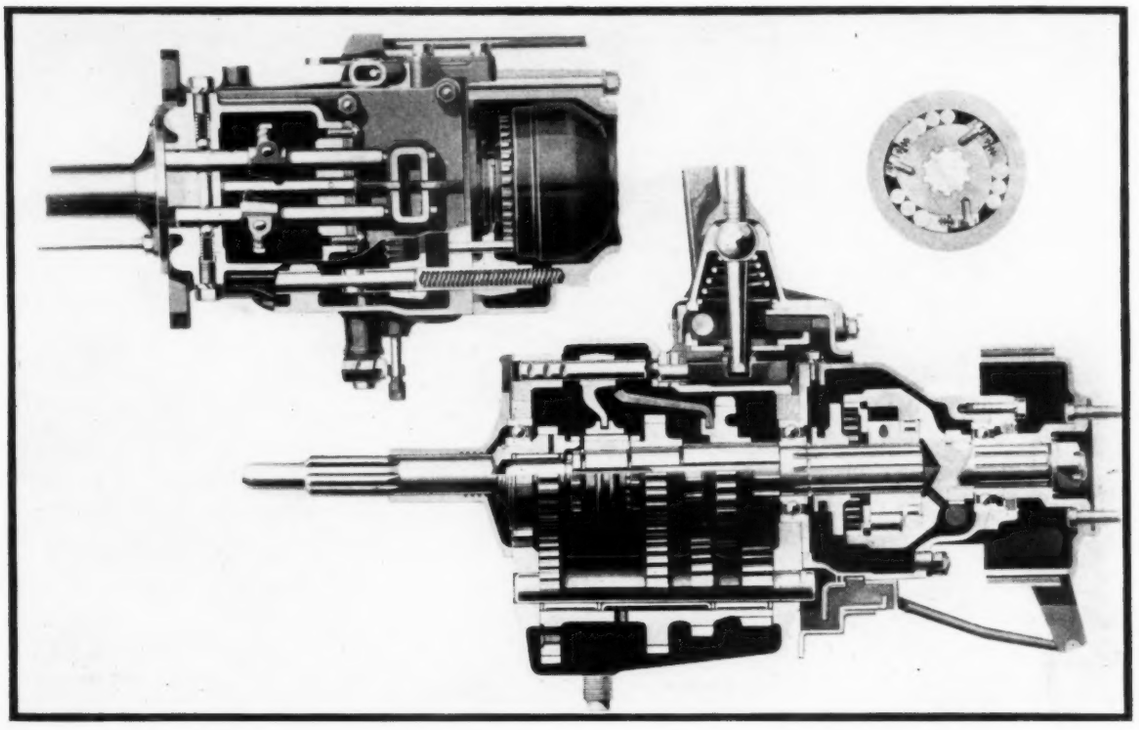
The "safety" steel body is designed to be made from stampings welded together. Running boards are also fabricated of pressed steel



STABILIZING spring and flexible supports for the powerplant, showing the rubber mountings and the pressed steel frame

with their rubber coverings vulcanized in place.

Convenience in operation is an important element of sales appeal. A new design of gearset is used in which the second-speed gears are in constant mesh, so that shifting from second to direct and vice versa may be done with a jaw clutch of the internal-external gear type having low spinning weight. This, together with the free-wheeling unit eases gear shifting, and the design permits shifting without declutching when



NEW CLUTCH, constant-mesh gearset and free-wheeling unit, important elements of the latest Plymouth model

the free-wheeling is not locked out. Control for the latter is placed on the instrument board and the operator consequently does not have to think about free-wheeling when shifting.

No conventional four-cylinder vertical engine can be made as nearly free from vibration as a six- or eight-cylinder type. Secondary inertia forces cannot be made to cancel out, and the torque variation, and consequently the torque reaction, is considerably more pronounced, especially when, as in conventional practice, the plane of support in the frame is a considerable distance from the center of gravity of the power plant. Having found it expedient to continue using a four-cylinder engine, Plymouth engineers were faced with the necessity of mounting the engine in such a way that its vibration and torque reactions would be transmitted to the frame, the body and the passengers as little as possible. An ordinary rubber mounting did not give the desired result because it is neither sufficiently resilient nor well placed in reference to the power plant center of gravity.

The construction selected involved the use of two rather soft rubber supports, one at the rear of the gearset and concentric with the main axis of the engine. A line passing through this axis just above this support and through the center of gravity of the powerplant passes also through the front engine support just below the fan axis at the front of the engine. Here a bracket is cast integral with the cylinder block and upper crankcase. It rests upon the forward support, a rubber block about 1 in. thick bonded to two steel plates bent to fit the parts with which they contact. This in turn rests upon a triangular bracket fastened to the front cross-member of the frame. Thus, the engine is free to rock about its gravity axis, within certain limits, under the influence of torque reactions. This motion is restrained somewhat in this design by a third point of attachment to the frame through a flat, 4-leaved stabilizer torque spring. Its large end is bolted to the clutch housing several inches below the gravity axis, and its small end is secured between a pair of rubber blocks attached to the main side rail of the frame. Thus the engine really floats in the frame, so far as torque reaction is concerned, and the soft rubber blocks absorb a considerable proportion of the vertical inertia forces.

Further to improve the insulation of the powerplant, its various connections to the chassis are designed to be as flexible as possible. The exhaust pipe, for example, is connected with a long, flexible elbow of asbestos composition. The clutch pedal is mounted on the frame and is connected directly to the powerplant only when the clutch is thrown out. Engineers placed a rubber

cover over the ball housing of the gearset shift lever, thus insulating that member from the floorboards, and connected the accelerator pedal at a neutral point so that it transmits a minimum of vibration. The handbrake lever is also mounted independently of the gearset.

Although the free-wheeling unit embodies a roller clutch similar to that used in kindred units, its design differs in other respects. It is mounted in a separate cast housing bolted to the rear of the gearset and rests directly upon the curved metal stampings to which the rear rubber mounting is bonded. The central or inner free-wheeling member is splined to the tailshaft of the gearset and has three arc-shaped surfaces, against each of which three graduated rollers bear. Between this and the outer member and centering the latter on the former is a straight roller bearing. All free-wheeling rollers bear against the bore of the outer member, and the latter is forged at its rear end into a splined tail shaft running in a ball bearing and carrying the hub of the handbrake drum. At its forward end, the outer member has internal gear teeth arranged to mate with those of a spur lock-nut gear of the same pitch diameter and splined to slide on the tailshaft of the gearset. These two gears form a positive clutch and when the male member is engaged by the Bowden wire control connected to a knob on the instrument board, the free-wheeling unit no longer functions as such, since both inner and outer members are then positively driven. In this design, when gears are thrown into reverse the free-wheeling unit is locked automatically, but is available in all three forward speeds. Connections are so planned that, after engagement in reverse it is not necessary to again push in the knob on the instrument board to free-wheel, but free-wheeling can be cut out whenever desired by pulling out the control knob, providing the speeds of the two halves of the positive clutch have been synchronized.

Partly to prevent the possibility of the engine stalling while idling when the car is free-wheeling, the engineers provided an automatic vacuum control to retard the spark. It is superimposed upon the normal automatic control, which is operated by centrifugal force. Actuation of the vacuum control is through a wire connected to a diaphragm acted upon by the considerable pressure drop which takes place in the engine manifold when the car coasts and the engine idles. At engine speeds equivalent to about 7 m.p.h. and above, spark position is controlled by the centrifugal advance mechanism designed so that engine torque is at its maximum values for higher speeds.

Engine power output has been increased through the use of a 4.9 compression ratio, as against 4.6 formerly. Its bore is $3\frac{5}{8}$ in. and its stroke $4\frac{3}{4}$ in., giving 196 cu.in. displacement. Its maximum power output is 56 hp. at 2,800 r.p.m. A double-slot oil ring and a thicker head were used in the piston design to reduce piston temperature and the detonation tendency at high temperatures. Pistons are cast from aluminum alloy. Unlike its competitors, the Plymouth engine incorporates positive pressure lubrication to all crankshaft and camshaft bearings. A combined air cleaner and intake silencer is fitted.

Although the clutch is described as a single dry-plate type, the driven plate is made up of two thin disks held apart at the periphery by flat springs. Each disk has a lining attached to its outer surface only. The springs are used to help bring these linings into gradual contact with the flywheel and heavy back driving plate, thus facilitating "soft" engagement and helping to secure easy getaway. Springs are interposed also between the driven hub that carries the two disks and the disks themselves further to cushion engagement and to avoid the transmission of engine chatter to the gearset.

Ball bearings are employed at each end of the main shaft of the gearset, and something approximating needle bearings, that is roller bearings which use rollers that are quite long in relation to their diameter, are employed for the pilot bearing and the countershaft. The helical gear for driving the speedometer shaft is mounted on the tailshaft of the free-wheeling unit and inside the same case, where excellent lubrication is assured. Hydraulic brakes are fitted to all wheels, and are another point of difference of this design from other cars in the lowest price range. One-way hydraulic shock absorbers also are fitted.

The extent to which instrument manufacturers are involved in the automotive field is apparent when it is realized that even this car in the lowest price class is fitted with a speedometer, ammeter, oil pressure gage, electrical gasoline gage, water temperature indicator, magnetic horn, windshield wiper, ignition switch and spot light. Such items are taken so much for granted today that it is not until one of them is examined in detail that one can realize how much engineers have done to make it possible to purchase a thoroughly modern automobile for a few hundred dollars.

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PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

September, 1931

. . . "It is amazing that we Americans should be so daringly progressive in all forms of applied science and engineering development, but so panicky, confused and reactionary in all matters of taste. . . Why cannot we carry the same courage with which we devise our products on to the determining of their visual form?" . . .

—WALTER DORWIN TEAGUE.

Appearance Counts

A RECENT survey indicated that only about seven per cent of engineers designing products consider appearance as one of the major considerations. Does this mean that product appearance is not essential, or does it mean that engineers have not yet awakened sufficiently to a realization of the sales qualities that must be designed into the product?

When executives of plants making such prosaic appliances as mechanical stokers call in an artist to put form and artistic appearance into the product, it is certainly time for the engineer to think more concernedly of incorporating appearance into the design in the first place. A few years ago buyers of construction machinery, power plant equipment, or machine tools did not question the factor of appearance if the machine worked well, but today they must consider its effect on the workmen and on its setting in their general plant scheme. Executives are now aware that unattractive, gloomy equipment makes dull workmen.

In consumer products the call for appearance is even more pressing. Sales talks of mechanical efficiency may have to be doubled or redoubled to put across a radio, washing machine, or electric refrigerator to the housewife if she is not attracted by the appearance or if the product appearance is such as to make an ugly spot in the home. There is no need to depreciate the importance of technical design, but hand in hand with that phase of design must go the thought that the product must be marketed, and when once sold must fit in as a part of people's lives.

■

Where the Product Fails

A CONSULTING metallurgist of standing remarked recently that in the great majority of instances where he was called in to explain material failures in a product he found that the material was not at fault. The real fault lay in the design of the product, or in the selection of material for the part that failed. Either the part was so designed that the material chosen could not possibly withstand the stresses involved, or else it was so designed that no material at anything like a reasonable cost could have stood up under the load.

In a way this comment is a serious indictment of the skill of the product engineer. He is supposed to know what materials to use, and to be able to design products that will not fail. On the other hand, it is expert evidence that even the ablest product engineer may go astray in making selections from the wide range of materials available.

Producers of materials can be of great service to the designer by developing exhaustive technical information on the characteristics of the various metallic and non-metallic substances. Such information would make advertising copy that would be interesting to engineer readers.

■

Eliminating the "Bugs"

A NEW born machine or product is far from perfect. There is bound to be an overlooked adjustment, a weak joint, a point of excessive wear, a lack of balance. The only effective way to work out the "bugs" is through actual use of the product in the field. Yet how many companies pamper the new baby in some back shed before it is finally announced to an eager public!

A progressive tractor and road machinery building company uses a different policy. It states in its house organ that there will be no timorous

delay in showing new products to its customers. They may not be perfect, but they are likely to be so far ahead of the old devices that their imperfections will be virtues in comparison. Those who see and use the machines can suggest beneficial changes, and swift improvement will follow wider adoption. One novel idea often engenders others.

In other words, this company is going to let its customers in on product development, but only, of course, after the big idea has been thoroughly proved. Not every company could safely follow such a policy, particularly when the product is sold in the general consumer field where ultimate customer reaction is hard to gage. In other, closer knit fields, it is possible to get sample products into the hands of friendly users who will co-operate in solving intimate design problems not always anticipated. Motor car manufacturers have their proving grounds. But whatever method is employed, the designer should not be satisfied until his creation has stood the test of actual use and he has assured himself that every criticism from the field has been investigated and answered.

■

Theory vs. Practice

IN THE July number of *Mechanical Engineering,* there is an abstract of an article that appeared in a Russian publication and seems to have been written by a German. Commenting on the different technique between German and American designers, he states that the American engineers consider the reduction of idle time of a production machine to be more important than a saving in time and cost of manufacture, and, therefore, the American does not hesitate to increase the cross sections 25 to 30 per cent over those which his strength and stiffness calculations indicate, and freely resorts to the use of expensive high-strength alloys. The American engineer is criticized for placing more dependence upon practical experience than scientific investigation in the solution of questions of construction.

It is evidently difficult for some people to understand that a scientific theory is nothing more than an accumulation of repeated experiences. Furthermore, our simplest laws of nature and so-called scientific relationships are never followed exactly in any instance. Hooke's Law, the basis of all strength and stiffness calculations, is not exactly adhered to by any known metal. Even in pure tension, the stress distribution is not uniform across the sections. Frictional forces vary considerably with speed, load and temperature, thus upsetting calculations for critical speeds and efficiency. Yielding of end connections of fixed beams appreciably changes the stresses from those calculated. And, over and above all this, it is impossible for any human being to predict the actual loads that may come upon the machine. Furthermore, the American designer does not expect that his product will receive 100 per cent service attention at all times, and therefore develops his design so that even if the machine be temporarily neglected, it will continue to operate satisfactorily at full capacity. It is false economy to risk a thousand to save a penny.

■

Cooperation in Product Development

HOW often is cooperation an empty name! Too frequently it means that one party is "cooperating" when it is willing to do what it is told. But to obtain the best in designs that will be made economically and will sell readily requires cooperation that gives and takes on all sides. The successful product of today must be a realization of the best thoughts in engineering, production, and sales.

The day when the sales department could take a product that was handed to it and sell it by high pressure is over. Likewise, it is not sensible to throw difficult parts into the shop to be made as best they can. The designer who does not assemble together every scrap of sales data dealing with suggestions and complaints before he begins his design is missing a bet. Furthermore, if he does not consult with the production executives as the design advances he is likely to be piling up trouble, delay, and expense for a later date. Cooperation in product development, on the other hand, does not mean ironing down to mediocrity by the satisfaction of everyone's petty demands, but rather an intelligent interpretation of requirements by the engineers and conversion of those ideals into a practical product that can be manufactured and sold effectively.

✦ COMMENT ✦ AND SUGGESTION

THE COMMENT AND SUGGESTION SECTION is a forum for exchange of opinion. Readers are invited to write letters discussing matters of current interest to development engineers. Articles of a controversial nature, however, will be published only with a bona fide signature.

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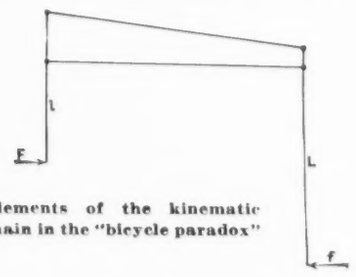
The Bicycle Paradox

By Frederick Franz
Consulting Engineer

THE "Bicycle Paradox" in *Product Engineering* on page 224, Vol. 1, may be simply explained as follows. The explanation takes into consideration the difference in sprocket diameters.

The accompanying figure is a representation of the elements of the kinematic chain, the uppermost link being the upper strand of the sprocket chain, operating at a larger radius at the pedal than at the rear wheel sprocket. The radius of the pedal, l, at which the force F is applied, is also shown shorter than the radius of the rear wheel, L. f is the reaction of the ground on the tire tending to propel the bicycle forward. F is the reaction between the ground and the pedal tending to propel the bicycle backward. The difference between these forces determines the direction in which the bicycle will move. Say Fl = moment about driving sprocket. Then the moment about rear axle, fL, will be less than Fl, owing to the sprocket reduction. Therefore, fL is



Elements of the kinematic chain in the "bicycle paradox"

less than Fl. Assume the L and l were equal; F would then be greater than f, yielding a net difference which would propel the bicycle backward. But L is greater than l, therefore, the net force propelling the bicycle backward is greater than assumed, and the bicycle *will* move backward.

If the small sprocket were placed on the pedal shaft and the large one at the rear axle, a real paradox would occur in that the bicycle would move forward when it is pushed backward.

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STOP... LOOK... LISTEN...

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. . . DIESEL IGNITION . . .

TARDY ignition is what is delaying development of the Diesel engine, and the time lag of the Diesel explosion over that of gasoline ignition is only 0.002 second, according to Professor P. H. Schweitzer of Penn State College. The Diesel engine is limited at present by this time lag to 2,000 r.p.m. as compared with a possible 7,000 r.p.m. in a gasoline engine. Determined efforts are being made overcome this by spraying the oil vapor at high pressure into the hottest part of the firing chamber.

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. . . CONVEYING MACHINERY . . .

HERE is a tip for engineers in conveying machinery, and it's from Germany. A 5,000 hen poultry farm has installed two belt conveyors under the wire mesh floor in the hen houses. One conveyor handles the soil and litter and the other carries the eggs to be washed and sorted. Belts also carry food to the hens and running water is always available on the opposite side. Farms may offer added fields for mechanization and so help out of the depression.

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. . . THE WAY OUT . . .

JULY production schedules up 30 per cent from those of a year ago, August still further increased, sales steadily mounting in spite of increased price—this sounds like a fairy tale. But it is the saga of the electrical refrigerator industry. The reason is obvious. Fifteen years of design work have finally culminated in the refrigerator of today—to the consumer a brand new product. Public acceptance and confidence are increasing because new models of this spring and their many improvements in design have won dormant buying interest.

Art for the Product of Today

By D. R. Dohner
Art Director, Westinghouse Electric & Manufacturing Company

[*The Editors asked Mr. Dohner to explain the similarity frequently noted between modern art applied to products and the older art forms. His answer is here.*]

MODERN art, as any truly vital art applied to products, derives its inspiration from things and conditions about us. A virile and lasting art grows out of and is related to our lives, our needs, our materials, and our methods of doing things.

For some time our art has been derivative rather than creative. For centuries we have derived our patterns and forms from the creations of past races. Always this art was modern when it was appropriate to the needs and conditions of the times. At no time was the break between periods so wide or severe as the one separating our age from the past. Since we are living in an age of science and invention, popularly called the machine age, it is only natural that mechanistic forms should inspire our truly creative men.

In an effort to break with the past, or at least the immediate past, our leading artists and designers have been compelled to wipe the slate clean, so to speak, and purge themselves of all the stubby, ornate and meaningless forms and decorations of other ages.

In so doing they no doubt approach the primitive in the simplicity and abstract nature of their work. After all, there is no doubt more inspiration and purely creative force back of even crude primitive art than in all the technically sleek endeavors of those of a sophisticated period.

The primitive must have used more reason in applying and relating his purely abstract patterns to his walls, his pottery, his baskets, his blankets and other objects of everyday use than artists of more enlightened periods who strove to imitate rather than transfer nature in their work. A slavish copying of an animal form

and naturalistically applying it to a rug without consideration to weaving limitations is not art.

I personally feel it is merely a coincidence when we find much of the better modern art resembling the work of primitive races. It is true we have mannerists and faddists and stylists who must copy the Egyptian today, the Persian and Assyrian tomorrow. I state again — there is something in common between the work of the Coptic, Aztec, Mayan, Inca and other primitives, and the sincere modern artist. I believe it is simply a case of getting back to a knowledge of simple fundamentals which somehow or other those early races possessed.

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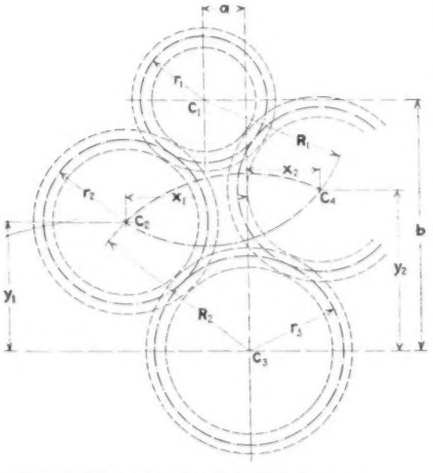
Locating the Center of an Idler

By Hans Schemm

IN designing cluster heads, driving heads for boring fixtures, and similar devices where two or more holes are to be bored, it is necessary to use an idler gear in order to obtain the same



Location of idler gear center, C_4 or C_2, for obtaining the same direction of rotation of spindles C_1 and C_3.

direction of rotation for all work spindles. In the figure C_1 and C_3 are the centers of the work spindles, and C_2 the center of the idler gear. The dimensions a and b are given on the part print, the dimensions x_1 and y_1 or x_2 and y_2 are to be found.

The following formulas were developed to avoid more or less tedious trigonometric calculations.

The equation of a circle, the origin of co-ordinates being at the center C_3 is:

$$x^2 + y^2 = R_2^2 \qquad (1)$$

The equation of a circle with its center at the co-ordinates a, b, (center C_1) is:

$$(x-a)^2 + (y-b)^2 = R_1^2 \qquad (2)$$

The intersections of these circles give the centers C_2 and C_4 of the idler, two solutions being possible. These two equations developed and solved for y, reduce to:

$$y_1 \text{ or } y_2 = \frac{\frac{1}{2}sb \pm a\sqrt{R_2^2(a^2+b^2) - \frac{1}{4}s^2}}{a^2+b^2} \qquad (3)$$

where $s = R_2^2 - R_1^2 + a^2 + b^2$

x_1 and x_2 can be found from:

$$x_1 = \sqrt{R_2^2 - y_1^2} \qquad (3a)$$

$$x_2 = \sqrt{R_2^2 - y_2^2}$$

If r_1 were equal to r_3 then R_1 would equal R_2 and (3) will simplify to:

$$y_1 \text{ or } y_2 = \frac{b}{2} \pm \frac{a}{2}\sqrt{\frac{4R^2}{a^2+b^2} - 1} \qquad (4)$$

■

Cast and Other Plastics

By Herbert Chase

AMONG the materials developed recently are certain plastics in the phenol-formaldehyde group, which instead of being formed from powder compressed and heated in molds, are cast in metal shells. The latter are made by dipping a steel form into molten lead and then plunging the form with its coating into cold water. When stripped from the form, the coating makes the mold into which the liquid plastic is afterward poured. Molds then are hung on racks or are placed in trays in an oven where they are cured at elevated temperatures. Although the process is slow, it results in producing some of the most beautiful plastics; clearly transparent, colored or mottled effect.

Materials of this class are said to have much the same physical and chemical properties as molded phenolic resins, being non-inflamable, odorless, tasteless, resistant to water and to most acids, and possessing high tensile and dielectric strength.

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Chain Drive Sprocket Formula

ON page 303 of the July number, the formula for the r.p.m. of the smaller sprocket should read:

$$\frac{1920}{P}\sqrt{\frac{A}{WP}}$$

. . . HOW LONG IS "NEW"? . . .

WILL Ford scrap his "new" Model A car and try to take the lead once more with a more modern design? That is what engineers are betting on just now. Model T was standard in design for many years, but the question now is how long can any product remain standard without redesign. Certainly not for very long. Chevrolet has forged ahead in sales, and has held the lead during 1931. Apparently the public is the judge of "newness." Will the answer be a price cut or a new design?

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. . . WHO INVENTS? . . .

ONLY 1,835, or 10 per cent, of the 18,373 engineers listed in "Who's Who in Engineering" have made inventions, according to Joseph Rossman, U. S. Patent Examiner. In discussing this subject Mr. Rossman writes that engineers do not appear to be creative, but rather copyists of past results. He places the blame partly on the engineering schools that do not encourage original or creative work from their students. Others have made this same statement about what Samuel W. Rushmore calls "soul-killing worship of precedent." Actually it is surprising how many inventors are not from the college-bred group. What is the true answer?

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. . . GIVE 'EM MORE OIL? . . .

USERS of machine tools frequently complain about the lack of provision for satisfactory lubrication of all bearings. "Why," they say, "don't designers of machine tools take a leaf out of the book of the automobile designer and provide ample lubrication all the time"? Of course it's different keeping oil on slides and ways than it is on shafts that are confined in metal boxes, but there may be a chance to cash in on the experience of the motor car.

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. . . CLOSED OR CONVERTIBLE? . . .

THERE has been talk of a decline in the popularity of closed cars, but the production figures for 1930 do not show it. Ninety per cent of all cars made during 1930 were closed. This percentage has mounted steadily from 10 per cent in 1919, and showed a gain of one per cent in 1930 over 1929. Will the convertible turn the tide to a drop in the 1931 percentage?

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. . . QUALITY METALS . . .

NOW with copper down to "the lowest price" there is much speculation about copper as a trade barometer and the effect of its price on business. But did anyone ever make an analysis of copper content in metal products? It is claimed that the proportional copper content increases with the increase in quality range of automobiles. Perhaps this ratio could also be revealed for other products—more brass, bronze, and cupro-nickel alloys as certain more exacting physical requirements are demanded where the extra cost of material will be warranted.

WHAT'S GOING ON—

Outstanding Engineer Interest In National Metal Congress

MORE than 200 manufacturers of materials, parts and equipment will exhibit their products at the National Metal Exposition, which will be held on Commonwealth Pier, Boston, Mass., Sept. 21 to 26. About 75,000 men from industry are expected to attend. Almost 70 papers dealing with the properties and uses of metals are on the tentative program of the A.S.S.T., and included in the list of authors are many foremost metallurgists and physicists. The A.S.M.E. will also have three or four design and metals papers, while the American Welding Society is expected to have about fifteen. The Society of Automobile Engineers will also hold one session, with several papers, and the A.I.M.E. will have a number of papers. Sessions will be held at the Statler, except those of the A.W.S., which will be at the Copley-Plaza.

Some 2,000 chemists from all parts of the United States will gather at Buffalo Aug. 30 for the eighty-second meeting of the American Chemical Society. Better protective coatings for automotive, marine, aircraft and railway manufacture will be urged at the meeting during a symposium on "Industrial Coatings from the User's Viewpoint." Improvements in automobile finishes will be discussed, as will methods of painting to give desired appearance at lower cost, greater resistance to rust and chipping from blows, and ways and means of replacing the traditional black fender with colored ones at no additional cost.

The American Electric Railway Association will hold its annual convention and exhibition at Atlantic City beginning Sept. 26. A number of exhibits of electrical railway equipment and supplies and many papers on various phases of the design and maintenance and operation of this equipment are included in the program, which will be reported upon more fully next month.

A detailed outline of the program of morning lectures and seminars and evening round-table discussions has been announced for the economic conference for engineers under joint auspices of the alumni of Stevens Institute of Technology and of Columbia Engineering School. The conference will be held from Aug. 29 to Sept. 7 at the Stevens Engineering Camp. Afternoons will be free for recreation.

Members of the Manufacturers' Section, American Gas Association, will meet in annual session Sept. 17–18 in the Book-Cadillac Hotel, Detroit. Separate sessions will be included for gas range, water heater, and space heater groups, and one opening general session will be held.

The American Management Association is sponsoring its second packaging, packing and shipping exposition at the Palmer House, Chicago, from March 7–12, 1931. During the week, conferences and clinics on design, application, use of packages, packing and shipping, and consumer marketing will also be held.

Engineering Notes

The American Machinery & Tools Institute, 40 North Wells St., Chicago, Ill., has announced a competition for designers and toolmakers for the design of the best drill jig in each of several types specified, to be used as model jigs in the standardization work of the Institute. Sketches or drawings are to be placed for preliminary review by Oct. 30, with finished drawings of the ten best in each class due Nov. 30.

Twenty new simplified practice recommendations were developed by general conferences during the fiscal year ending June 30, 1931, raising the total number of these recommendations to 149, according to EDWIN W. ELY, chief of the Division of Simplified Practice, National Bureau of Standards, in a recent report.

The U. S. Patent Office will be moved before the expiration of the year into the entire north third floor of the new Commerce Building. About 10,000,000 copies of patents already issued will be kept in stock for sale, and a huge research room and a large library will be included for scientific investigators. Of interest is the fact that the Patent Office, organized in 1790, had issued but 40,000 patents by 1870, while that many are now issued each year.

Nordenholt on Design Committee

A Committee on Machine Design has been appointed by F. C. SPENCER, chairman of the Machine Shop Practice Division, A.S.M.E. This committee will arrange for papers on machine design to be presented at meetings of the Society and will, in general, coordinate the activities of members interested in this phase of engineering and manufacturing. Those appointed are: FRANK L. EIDMANN (chairman), professor of mechanical engineering, Columbia University; JOSEPH B. ARMITAGE, chief engineer, Kearney & Trecker Corp.; G. H. ASHMAN, engineer, General Electric Co.; GEORGE F. COSGROVE, president, Cosgrove Technical Service; GEORGE F. NORDENHOLT, associate editor, *Product Engineering;* FREDERICK FRANZ, consulting engineer; and ALBERT PALMER, assistant to the general manager, Crompton & Knowles Loom Works

News of the Metal Markets

WHEN copper dropped to 10c. it was not considered possible for it to remain long at that figure or to go much lower, but it has not only dropped to 7.50c. but, according to *Metal and Mineral Markets*, has held steadily at that price during the first weeks of August. American mine production of copper declined during July, but stocks on hand Aug. 13 showed a net gain of 18,351 tons. One bright spot in the industry is the steady consumption by the power utility companies.

STEEL ingot production dropped to 32 per cent of capacity in July as compared with 36 per cent for the low point of last December. There has been an effort to stabilize prices for bars, shapes and plates at $1.60 with some concessions to large buyers.

ZINC stocks were reduced due to the curtailment in production, sales being about the same as during June. The price Aug. 13 was 3.825c. per lb. St. Louis.

More than half of the present lead business is in corroding lead. The business in this metal has been dull for July and August, but there has been no thought of reducing the price, which is 4.225c. St. Louis, and 4.40c. New York.

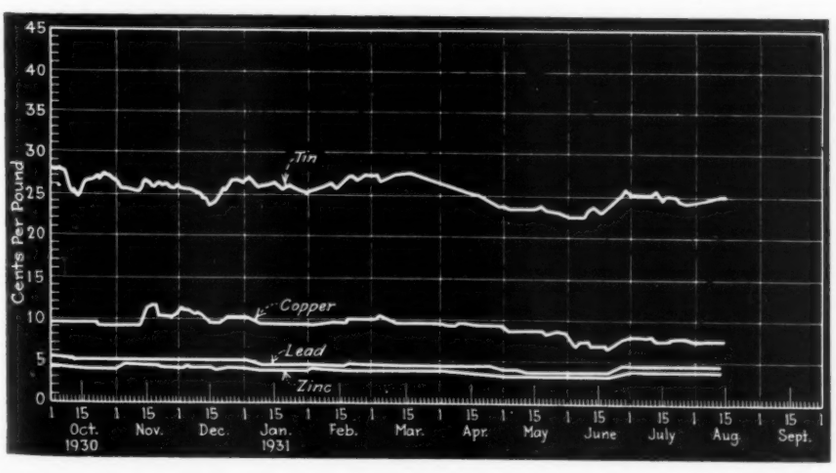
TIN prices moved up to 26c. during the second week of August on news of projected curtailments in production. It is probable that the production quotas already set will be cut down further. According to figures given out by the U. S. Bureau of Mines, the United States is consuming half of the world's output of tin, although this country produces only a negligible amount.

SILVER prices dropped again in August, and with the price below 30c. an ounce the metal has become available for many uses. Jewelry manufacturers who formerly used base metals are now frequently using the solid metal. Many novelties are also being made of silver, and much sterling silver tableware is appearing on the market at prices little above the former prices for plated articles.

Standards and Specifications

New Federal specifications include QQ-F-191 for ferrotitanium, succeeding USGMS 144, QQ-C-501 superseding USGMS 467 on copper bars, plates, rods, shapes, sheets and strips, QQ-I-651 on gray iron castings to supersede USGMS 141, QQ-I-656 on high-test semi-steel gray iron castings to supersede USGMS 140, QQ-M-161 on anti-friction metal castings and ingots to supersede USGMS 536, QQ-S-681 on steel castings to supersede USGMS 170, GGG-F-671 on hacksaw frames to supersede USGMS 479, GGG-S-291 on tinner's shears to supersede USGMS 451, T-R-571 on cotton rope to supersede USGMS 447, a proposed specification for 250-lb. threaded bronze pipe fittings and one for electrical metal tubing.

American tentative standard safety code for protection of industrial workers in foundries, approved by the ASA in 1922, is now being brought up to date. The ASA has approved American tentative standard specifications for zinc-coated (galvanized) sheets of bessemer steel, open-hearth steel and iron. The ASA has also approved a new national safety code for elevators, dumbwaiters and escalators.



Meetings

American Chemical Society—Eighty-second meeting, (Papers on metals and protective coatings), Buffalo, N. Y., week of Aug. 31. Charles L. Parsons, secretary, Mills Bldg., Washington, D. C.

Society of Automotive Engineers—National Aeronautic meeting, Hotel Statler, Cleveland, Ohio, Sept. 1-3. John A. C. Warner, secretary, 29 West 39th St., New York, N. Y.

Electrochemical Society — Annual meeting, Hotel Utah, Salt Lake City, Utah, Sept. 2-5. Colin G. Fink, secretary, Columbia University, New York, N. Y.

International Association for the Testing of Materials — First International Congress, Zurich, Switzerland, Sept. 6-12. Information from C. L. Warwick, 1313 Spruce St., Philadelphia, Pa.

American Society of Mechanical Engineers—Design papers in conjunction with Southwest Power Conference, Kansas City, Mo., Sept. 7-9. Calvin W. Rice, secretary, 29 West 39th St., New York, N. Y.

National Association of Power Engineers—Annual convention and mechanical exposition, Kansas City, Mo., Sept. 7-11. Fred W. Raven, secretary, 417 South Dearborn St., Chicago, Ill.

Steel Founders' Society of America, Inc.—First fall meeting, Chicago, Ill., Sept. 17. Granville P. Rogers, managing director, 932 Graybar Bldg., New York, N. Y.

National Metal Congress and Exposition—Exposition on Commonwealth Pier, congress sessions at Hotel Statler, Boston, Mass., week of Sept. 21. W. H. Eisenmann, secretary A.S.S.T., 7016 Euclid Ave., Cleveland, Ohio.

American Welding Society — Semi-annual meeting, Boston, Sept. 21-25. M. M. Kelly, secretary, 33 West 39th St., New York, N. Y.

American Society for Steel Treating—In connection with the National Metal Congress, Boston, Sept. 21-26. W. H. Eisenmann, secretary, 7016 Euclid Ave., Cleveland, Ohio.

American Society of Mechanical Engineers—Sessions in connection with the National Metal Congress, Hotel Statler, Boston, Mass., week of Sept. 21. Calvin W. Rice, secretary, 29 West 39th St., New York, N. Y.

Society of Automotive Engineers—Session on problems of automotive industry regarding metallurgy, production and cost, Hotel Statler, Boston, Mass., week of Sept. 21, during National Metal Congress. John A. C. Warner, secretary, 29 West 39th St., New York, N. Y.

International Foundry Exhibition and Congress—Annual exhibition of foundry equipment, castings, and raw materials, Milan, Italy, Sept. 12-17. C. Vanzetti, chairman of the general executive committee, Via Verdi, N. 11, Milan, Italy.

British Institute of Metals—Annual autumn meeting, Zurich, Switzerland, Sept. 13-15. G. Shaw Scott, secretary, 36 Victoria St., Westminster, London, S.W.1.

American Electric Railway Association—Annual meeting and exposition, Atlantic City, N. J., Sept. 26-Oct. 2. Guy C. Hecker, general secretary, 292 Madison Ave., New York, N. Y.

American Gas Association—Annual convention and exposition, Municipal Auditorium, Atlantic City, N. J., Oct. 12-16. Kurwin R. Boyes, secretary, 420 Lexington Ave., New York, N. Y.

National Safety Council—Twentieth annual Safety Congress (show in connection) Stevens Hotel, Chicago, Ill., Oct. 12-16. W. H. Cameron, secretary, 20 North Wacker Drive, Chicago, Ill.

Gray Iron Institute—Fourth annual convention, West Baden Springs Hotel, West Baden, Ind., Oct. 15-16. J. Arthur Tuscany, secretary, Terminal Tower, Cleveland, Ohio.

Steel Founders' Society of America, Inc.—New York meeting, Oct. 22. Granville P. Rogers, managing director, 932 Graybar Bldg., New York, N. Y.

Dairy & Ice Cream Machinery & Supplies Association—Annual meeting and exposition, Atlantic City, N. J., Oct. 26-31. C. E. Breece, secretary, 225 West 34th St., New York, N. Y.

IN THE SPOTLIGHT—

DR. M. LUCKIESH and FRANK K. Moss of the Nela Park Lighting Research Laboratory, General Electric Co., Cleveland, Ohio, have been awarded the gold medal of the Distinguished Service Foundation of Optometry, for creating a new science of seeing, a combination of lighting and optics scientifically applied.

H. J. ALTER has become an engineer and designer for Fleetwings, Inc., Garden City, Long Island, N. Y.

H. P. ANDERSON has been appointed chief engineer in charge of engineering, inspection, testing and development activities for the Standard Stoker Co., Erie, Pa.

ALFRED LEROY ATHERTON will head a new Metal Tank Mercury Arc Rectifier Division within the Circuit Breaker Engineering Department of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WILLIAM B. BARNES, formerly in charge of research and experimental work for the Auburn (Ind.) Automobile Co., since 1927, has become consulting engineer for the Schwitzer-Cummins Co., Indianapolis.

MILTON C. BAUMANN, formerly chief engineer of the Inland Aircraft Co., Kansas City, Kan., has joined the Great Lakes Aircraft Co., Cleveland, Ohio.

H. V. THADEN, formerly vice-president and general manager of the Metalair Corp., Pittsburgh, has been placed in charge of the Fokker Aircraft Corp.'s manufacturing division as factory manager and acting chief engineer. In the latter position he succeeds ALFRED A. GASSNER.

WILLIAM R. BLAKELY, formerly assistant chief engineer with the Huntington Aircraft Corp., Stratford, Conn., has become an engineer with the Kreider Reisner Aircraft Co., Hagerstown, Md.

ROBERT E. BUSEY, formerly a designer with the Chrysler Motor Corp., has become a designer for the Hupp Motor Car Co., Detroit.

CHARLES N. COLSTAD, works manager and chief engineer of the Apco-Mossberg Corp., Attleboro, Mass., for the past four years, has resigned to devote his entire time to consulting, design and research work, specializing in automotive accessories and equipment.

GEORGE H. KUBLIN, assistant chief engineer of the Auburn (Ind.) Automobile Co., has been appointed chief engineer.

F. W. COOK, formerly with the Marvel Carburetor Co., has joined the Carter Carburetor Co. in an engineering capacity and will be located in the Detroit office of the company.

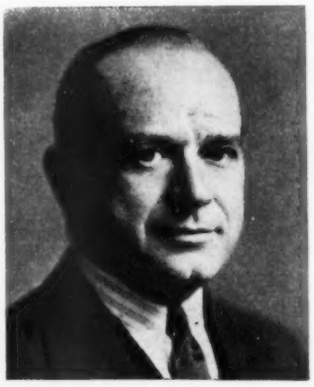
LAURENCE J. GRUNDER, formerly automotive research engineer with the Hughes Development Co., Ltd., Hollywood, has joined the Southern division of the Richfield Oil Co., of California, as an automotive engineer and will be located in Los Angeles.

PROF. S. W. DUDLEY, professor and chairman of the Mechanical Engineering Department, Yale University, has rejoined the engineering organization of the Westinghouse Air Brake Co., Wilmerding, Pa., in an advisory capacity. He will be assistant to the vice-president and will retain his university connections. He was with Westinghouse from 1905 to 1921, for the last seven years as chief engineer.

SAMUEL D. FITZSIMMONS, for many years plant engineer of the Brown & Sharpe Mfg. Co., Providence, R. I., has become vice-president of the Narragansett Electric Co., Providence.

Dr. M. Luckiesh

H. V. Thaden



G. H. Kublin

RANDOLPH F. HALL, formerly of the Thomas-Morse Aircraft Corp. and until recently chief engineer of the Cunningham-Hall Aircraft Corp., Rochester, N. Y., has resigned from the latter company.

KENNETH R. HERMAN, chief engineer of the DiVco-Detroit Corp., Detroit, has resigned to become a development and sales engineer, with headquarters in Detroit, of Vickers, Inc.

S. K. HOFFMAN, formerly research engineer in the General Motors Corp. Research Laboratory, Detroit, has become an engineer with the Lycoming Mfg. Co., Williamsport, Pa.

FERDINAND JEHLE, research engineer of the White Motor Co., Cleveland, Ohio, received the degree of mechanical engineer from the University of Illinois.

CHARLES I. HUMMER, formerly engineer with the U. S. Wheel Track-Layer Corp., Rahway, N. J., has joined the Magar Car Corp., Passaic, N. J.

LELAND A. HURD has become Air Corps representative in charge of inspection for the United States Army Air Corps, and will be located at Buffalo.

LESTER S. KEILHOLTZ, technical assistant to the president of the Frigidaire Corp., Dayton, Ohio, has become general research manager for Montgomery Ward & Co. He began with the Domestic Engineering Co. in 1916 as chief engineer. From 1921 to 1928 he held the same position with the Delco-Light Co. From 1921 to 1929 he was also chief engineer of the Frigidaire Corp., and in the last named year became technical assistant to the president.

DR. G. L. KELLEY, scientist of Harvard University, has been appointed to supervise research work in the manufacture of pressed steel coaches at the Pressed Steel Company of Great Britain, London, England.

ANDREW L. KIMBALL, formerly experimental engineer in the special study department, General Motors Corp., in Detroit, has taken similar duties with the Olds Motor Works, Lansing, Mich.

T. R. LANGAN, with the Westinghouse Electric & Mfg. Co., for more than 20 years, and who started as an apprentice in the engineering department, has just been made Northeastern district manager with headquarters in New York City.

HANS W. LINDEMANN, formerly passenger-car chassis designing engineer for the Nationale Automobil-Gesellschaft, Berlin, Germany, has become a designing engineer with the Buessing-Nag works, Leipzig, Germany.

WALTER M. LIPPS, formerly assistant chief engineer in the automotive division, American Cable Co., Detroit, Mich., has been appointed sales representative in the Indianapolis district for the Russell Mfg. Co., Detroit.

DONALD J. LOWMAN, engineer in the aeronautic division of the Lycoming Mfg. Co., Williamsport, Pa., has become experimental engineer in the engine division of the American Plane & Engine Co., Farmingdale, N. Y.

ANTHONY H. G. FOKKER resigned as director of engineering of the General Aviation Corp., New York, recently, although he continues as a director and large stockholder. He will form the International Fokker Corp., which is to bring into one organization the interests of companies throughout the world engaged in manufacturing airplanes under Fokker licenses. The nucleus of the new company is to be the Dutch Fokker Aircraft Co. ALBERT A. GASSNER, formerly chief engineer of the General Aviation Corp., and the Fokker Aircraft Corp., will join the new Fokker Corporation.

L. D. MEAD has been made chief engineer of the DiVco-Detroit Corporation. He was formerly designing engineer of trucks and buses at Studebaker and Pierce-Arrow and before that chassis engineer for Dodge-Graham.

E. J. MEHREN, Chicago vice-president of the McGraw-Hill Publishing Co., publisher of *Product Engineering*, who, during his 22 years with the organization, played a most important part in the development of its many properties and of the institution itself, has resigned to become president of the Portland Cement Association.

F. U. MOREHEAD, chief engineer of the Walworth Mfg. Co., Boston, Mass., has been elected vice-president in charge of engineering.

H. H. MORGAN, formerly assistant chief engineer in charge of the drafting room of the Palmer-Bee Co., Detroit, and prior to that time on the engineering staff of the Webster Mfg. Co., Chicago, now affiliated with the Weller Mfg. Co., has been made special engineering representative for the Weller Co. in Detroit with offices at 10228 Woodward Ave.

E. W. LOOMIS, recently honored with the honorary degree of electrical engineer by the University of Delaware, and a graduate engineer of that institution, has been appointed Middle Atlantic district manager of the Westinghouse Electric & Mfg. Co., with headquarters in Philadelphia. He has been connected with the Westinghouse sales department for some years.

LEONARD V. NEWTON, automotive engineer of the Byllesby Engineering & Management Corp., Chicago, has been appointed a member of the Aeronautic Commission of the City of Chicago by Mayor Cermak.

FRANK CROFFORD RUSHING of the Industrial Motor Engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has received the Lamme Memorial Scholarship Award which will enable him to spend the school year of 1931-1932 at the Universities of Charlottenberg and Berlin, Germany.

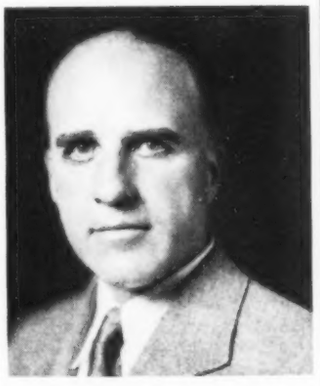
CALVIN W. RICE, secretary of the A.S.M.E., received an honorary award at the recent seventy-fifth anniversary meeting of the Verein deutscher Ingenieure, consisting of a silver plaque especially struck to commemorate the founding of the V.D.I. at Alexisbad in 1856.

DAVID E. ROSS, vice-president and general manager of the Ross Gear & Tool Co., Lafayette, Ind., from 1906 to 1927, and inventor of the Ross cam-and-lever steering-gear, has been elected to the presidency of that company and also the Fairfield Mfg. Co., Lafayette, Ind., following the sudden death of EDWARD A. ROSS, formerly president.

W. G. STERNBERG, formerly president of the Sterling Motor Truck Co., Long Island City, N. Y., has been made a vice-president of the Sterling Motor Truck Company of California, Los Angeles.

MORTON C. SWIFT, previously test engineer for the Pratt & Whitney Aircraft Company, East Hartford, Conn., has become an automotive engineer with the general laboratory of the Standard Oil Co. of New York, Brooklyn.

Anthony H. G. Fokker



E. W. Loomis

Frank C. Rushing

C. C. TRUMP, formerly president and mechanical engineer of the Trump Corp., Syracuse, N. Y., has joined the James Spear Stove & Heating Co., Philadelphia.

ALFRED TUCKING, formerly a designer with the Packard Motor Car Co., Detroit, is now employed by the Chrysler Corp., Highland Park, Mich., as a mathematician.

RALPH H. UPSON received the honorary degree of aeronautic engineer at the 59th annual commencement of Stevens Institute of Technology at Hoboken, N. J., in recognition of his achievements as designer and builder of the experimental metal-clad airship ZMC-2.

CLARENCE W. VOGT, inventor of a continuous pressure freezer and some 20 other refrigeration units, and his entire staff of Vogt Instant Freezers, Inc., have become associated with The Borden Co., New York, in the capacity of technical advisors on freezing and refrigeration.

ROY J. WENSLEY, creator of the Televox, first of the mechanical robots, has been transferred from the East Pittsburgh Engineering Department, Westinghouse Electric & Mfg. Co., to the Meter Department, Newark Works.

RONALD WILSON, formerly of the engineering staff, Brown & Sharpe Mfg. Co., Providence, R. I., has joined the engineering staff of the Superior Machine Tool, Kokomo, Ind., on designs of special machines.

CHARLES A. WINSLOW has been made vice-president and general manager, and JOHN THYSSE has been appointed chief engineer, of the Standard Gas Engine Co., Oakland, Calif. Their previous post were development engineer and assistant chief engineer of the Hercules Motor Corp., of Canton, Ohio. Mr. Winslow is widely known for his work in connection with the developing and manufacturing of various types of filters, carburetors, air-cleaners, and ventilating systems. Mr. Thysse received his engineering education in Holland and Germany and has been associated with leading Diesel marine-engine manufacturers in Europe. He has also been with the Diesel-engine division of the Worthington Pump & Machinery Co. and the Hill Diesel Engine Co.

ROBERT S. WINTER, formerly production manager with the Freeman Motor Company, Detroit, has become an experimental engineer with the Brunswick Radio Corporation, Muskegon, Mich.

GEORGE W. YANSS, chief engineer for the past two years of the Eastwood Wire Corporation, Belleville, N. J., has resigned to become staff engineer of the Bridgeport (Conn.) Brass Company on the development of automotive accessories, and will be contact man with engineers in the automotive industries on engineering and sales. While with the Eastwood company, Mr. Yanss developed the design of the company's oil strainers and a varied line of accessories.

NEW MATERIALS AND PARTS AND ✦ ENGINEERING EQUIPMENT ✦

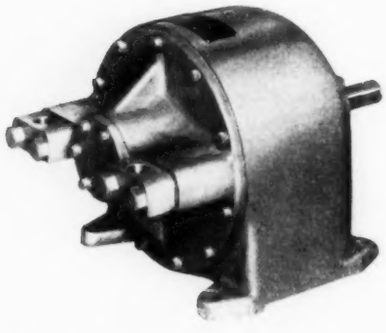
Oilgear Type RQ-2 Fluid Motor

A constant-displacement fluid motor is announced by the Oilgear Company, Milwaukee, Wis., for use in combination with its Type QR-2 variable-delivery pump to provide a variable-speed transmission. This Type RQ-2 unit can be applied to conveyors, paper mill drives and other machinery where smooth rotary motion and variable speed are required. Large grinding machine tables also can be reciprocated with these units by means of a rack and pinion connection.

A series of speed ratios practically independent of variations in load are available with the Oilgear transmission. Any constant-speed source of power can be used to drive the variable-delivery pump, and by varying its output, the fluid-motor speed can be varied from 0 to 800 r.p.m. The accompanying table gives the torque and power ratings for various pressures.

TORQUE AND POWER RATINGS

Pressure Lb. per Sq.In.	Starting Torque In.-Lb.	Running Torque In.-Lb.	Max. Output, Hp.
500	140	150	1.9
1,000	285	300	3.9
1,500	425	450	6.0
1,750	500	525	6.9



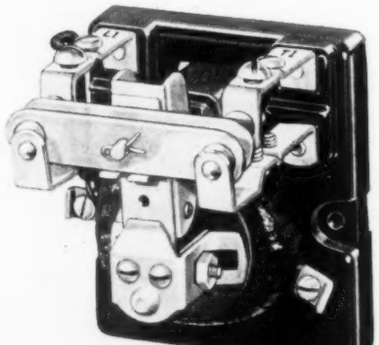
Oilgear Type RQ-2 constant-displacement fluid motor for use in a variable-speed transmission

Working parts used in the fluid motor are similar to those used in Oilgear variable-delivery pumps, except that the stroke of the pistons is fixed. Positive speed control is obtained by a single lever on the variable-delivery pump. The two units are usually connected by a $\frac{3}{4}$-in. pressure and return line, together with a $\frac{3}{4}$-in. drain line. Ordinarily the motor rotates only in one direction, which can be reversed by interchanging the pipe connections on the motor.

Net weight is 200 lb.

Allen-Bradley Bull. 201 and 701 Contactors

Normally closed and up-and-down contractors for a.c. and d.c. service have been announced by the Allen-Bradley Company, 1311 S. First St., Milwaukee, Wis. The Bulletin 201, Form D, d.c., and Bulletin 701, Form D, a.c., contactors are provided with "down" or "back" contacts against which a single-pole contactor arm is held when the operating coil is not energized. When the coil is energized, the circuit is opened. This type of contactor is made especially for relay work.



The Form E contactors are two-wire, single pole, "up-and-down" contactors, provided with a double set of single-pole stationary contacts and a double contactor on the contactor arm. The two circuits are insulated from each other, one being normally closed and the other open. When the operating coil is energized, this connection is reversed. This method of control is used when double-throw, single-pole, magnetic operation for two-wire separate or common control is necessary.

Westinghouse Steel Mill Motor

A steel mill motor, designed for heavy-duty applications such as steel-mill auxiliary drives, cranes, hoists, shovels, coal and ore bridges, mine hoists, railway turntables, transfer tables, railway lift bridges, traffic bridges and conveyors, has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The design of this motor embodies recommendations by the Association of Iron & Steel Electrical Engineers. The field coils and poles are positively secured to the frame without the necessity for washers, springs or other parts likely to become loose and cause damage. The bearing housings are held securely from turning by a clamp on each side and accommodate interchangeably

either ball or roller bearings of any standard make, and for either grease or oil lubrication. Laminated commutating poles prevent injurious sparking, particularly in plugging and reversing. This construction gives high overload capacity.

The motors have massive cast-steel frames, which are split horizontally, so the top half can be swung back without disconnecting any leads. The halves are carried on self-supporting hinges for all frames, which makes convenient the removal of the armature bearings.

Champion Gage Protector

Protection to gages used on air and hydraulic lines is afforded by the gage protector announced by Champion & Barber, Inc., 576 Subway Terminal Building, Los Angeles, Calif. This gage protector eliminates passage of injurious fluids or solids into the tube

Champion Gage Protector Assembly

or movement of the gage. It increases accurate service life and makes an ordinary gage into an all-purpose type, eliminating special adaptation for special conditions. It is comprised of a three-part, bronze bodied, rubber-bulbed pressure transmitting instrument. The pressure transmitting bulb is filled with glycerine or caster oil, and is at all times in direct contact with the exterior line pressures and the interior bulb fluid pressures. The bulb is specially treated for resistance to acids and other fluids. The parts of the gage protector are as follows: (1) main body; (2) needle valve adjustment screw for pulsator control; (3) packing and lock nuts; (4) neck or gage protector, and (5) main body of protector, containing the pressure bulb.

Vickers Hydraulic Relief Valve

A hydraulic relief valve (balanced) has been announced by Vickers, Inc., 7742 Dubois St., Detroit, Mich. Instead of the customary spring-loaded construction, the valve is operated by a piston that is in hydraulic balance regardless of the initial oil pressure and the pressure for which the valve is set. Consequently, it is sensitive and accurate throughout the pressure range. The valve can be installed directly in the line and in any position. This eliminates the customary

Vickers Hydraulic Relief Valve, which has a balanced piston

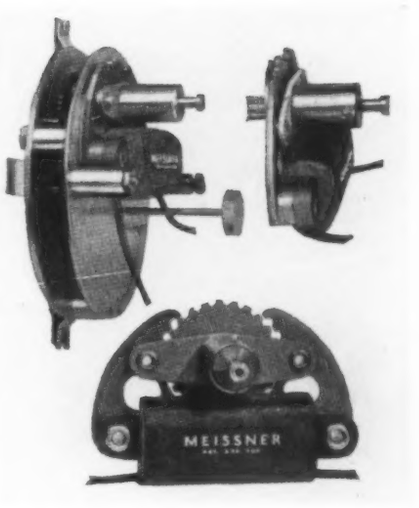
tee and results in a neater and more compact installation. Longer life is assured by the alloy-steel working parts that are hardened and ground.

A hydrocone-shaped valve prevents wire drawing and eliminates oil foaming that would aerate the oil. The valve is non-surging and the operation is quiet because of the employment of the balanced piston.

The valve is made in two sizes for $\frac{3}{4}$- and $1\frac{1}{4}$-in. pipe connections, and the capacities are 0 to 15 gal. per min. and 10 to 40 gal. per min., respectively. The pressure range for both valves is from 0 to 2,000 lb. per sq.in.

Meissner Miniature Synchronous Motor

A self-contained synchronous motor for the drive of clocks, toys, electrical novelties, window displays and other light power applications, has



Meissner Miniature Synchronous Motor, which consumes $2\frac{3}{4}$ watts

been announced by the Meissner Manufacturing Co., 522 S. Clinton St., Chicago, Ill. The illustration shows the motor by itself and also attached to a clock mechanism. Mounting is accomplished by the use of two screws.

The complete unit has overall dimensions of $2\frac{1}{4}$x$1\frac{7}{8}$x$1\frac{1}{2}$ in. Starting is by hand by means of a knurled knob mounted on the end of the armature shaft. The motor consists of a field coil, two-pole core, and two-piece rotor, combining a magnetic flywheel and a toothed armature.

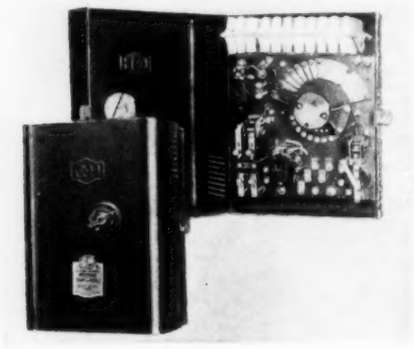
The flywheel is mounted directly alongside the armature and rotates freely with respect to it, alternately lagging and leading the armature, which is keyed to the drive shaft. The motor is designed to operate on 110-volt, 60 cycle current at a speed of 300 r.p.m. Its power consumption is $2\frac{3}{4}$ watts.

Cutler-Hammer D.C. Speed Regulator

Cutler-Hammer, Inc., 296 North 12th St., Milwaukee, Wis., has announced the Bulletin 6410 automatic-starting speed regulator for d.c. motors up to 3 hp. This regulator is of the counter E.M.F. type, non-reversing, and is arranged to give 50 per cent speed regulation below normal by armature control and 100 per cent increase by field weakening. It is designed for constant-torque duty where the load is constant and independent of the speed, such as for the motors of printing presses, folders, paper-box making machinery, textile machines and similar equipment.

Features of this controller are auto-

NEW MATERIALS AND PARTS

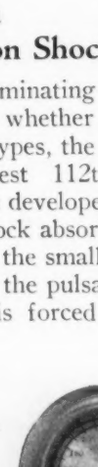


Cutler-Hammer D.C. Speed Regulator of the counter e.m.f. type

matic starting with a definite, high starting torque; predetermined speed setting by means of the speed setting knob on the front; a vibrating field relay assures starting with a full field; dynamic braking when stopping; two- or three-wire remote control of starting and stopping; split-type inclosing case makes all parts accessible when opening the door; and the resistor is mounted above the panel and easily accessible.

Meriam Pulsation Shock Absorber

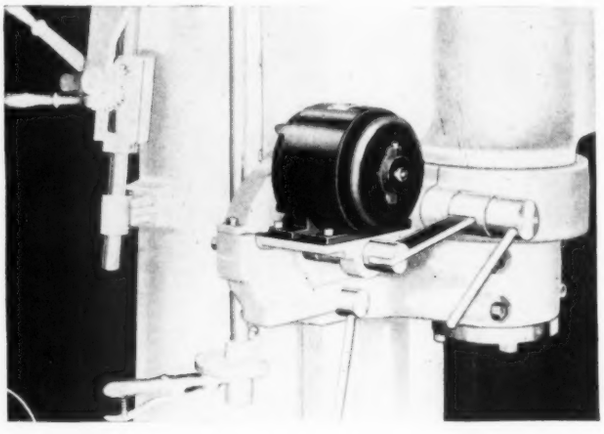
For eliminating unsteady readings of gages, whether of the pressure or vacuum types, the Meriam Company, 1955 West 112th St., Cleveland, Ohio, has developed an improved pulsation shock absorber. The device is placed in the small line leading to the gage and the pulsating pressure from the line is forced to reach the gage through a considerable length of fine tubing coiled closely within the compression air-chamber of the gage. This "air-receiver" action, combined with the friction of the fluid in the fine tubing, absorbs the fluctuations of the gage line pressure and gives the true line pressure. The absorber is only 7 in. high and has no moving parts. All joints are welded to prevent leakage. These absorbers are designed for line pressures up to 10,000 lb. per sq.in.



Meriam Pulsation Shock Absorber connected up to a pressure gage. The gage is not furnished

Ohio Torque Motors

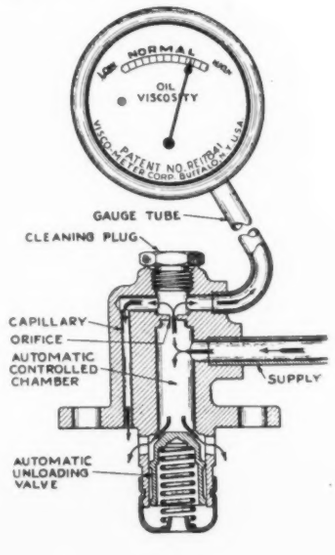
Slow-speed torque motors (or rotating magnets) are being offered for general use by the Ohio Electric Manufacturing Company, 5900 Maurice Ave., Cleveland, Ohio. The illustration shows a torque motor used to clamp the arm of a large radial drill. In this case the arm may be unclamped by reversing the motor and the clamp will remain in either clamped or unclamped positions, with the current off the motor. The motor is wound, however, so that it may be stalled, with the current left on, if necessary, for indefinite periods, without overheating or burning out.



These torque motors are generally wound so that they will rotate at 600 or 1,200 r.p.m. if not opposed, but they may drive the load at any lower speed as determined by the load itself and without danger to the motor. It is useful for any purpose for which an electric solenoid or air or steam power might be used. The motors may be wound for d.c. or polyphase a.c. and to a limited extent for single-phase a.c. They are built to suit the work in hand.

"Visco-Meter" Viscosity Indicator

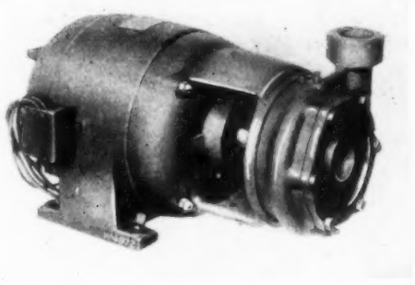
A viscosity indicator for engines and other machines using pressure lubrication has been developed by the Visco-Meter Corporation, 315 Grote St., Buffalo, N. Y. Instead of using the principle of gravity flow as in most viscosity testing apparatus, this "Visco-Meter" utilizes the principle of constant pressure. This device is connected with the oil-pressure line in equipment where working pressures exceed 8 lb. per sq.in. An automatic unloading valve reduces a small portion of the oil to a pressure of 5 lb. per sq.in. in the automatically controlled chamber. The oil then passes through the calibrated orifice into a divided chamber. One branch is connected with a calibrated capillary resistance tube at the left, the opposite branch to the registering gage. The gage is marked "low," "normal" and "high." The low, or danger zone, begins at 55 Saybolt seconds. High is also in the danger zone and reads up to 900 Saybolt seconds. The normal portion of the gage has a range wide enough to allow for the natural changes in the lubricating value which takes place in all oils during use, but which are not injurious to the machine. The "Visco-Meter" indicates when the oil is becoming too thin and thus gives warning to change it.



NEW MATERIALS AND PARTS

Worthington Type D Centrifugal Pump

A centrifugal pump of good efficiency, low initial cost and low maintenance expense has been developed by the Worthington Pump & Machinery Corp., Harrison, N. J. This "Monobloc" Type D centrifugal unit comprises a pump bolted to an extended motor frame, and having the impeller mounted on the end of the continuous motor shaft. The bronze impeller incorporates a shaft sleeve as an integral part for shaft protection. A special cadmium-plated steel locking device is provided on the impeller. Other features are the forged bronze packing gland, the arrangement of the shaft water-throwers, and the ball-bearing motor.



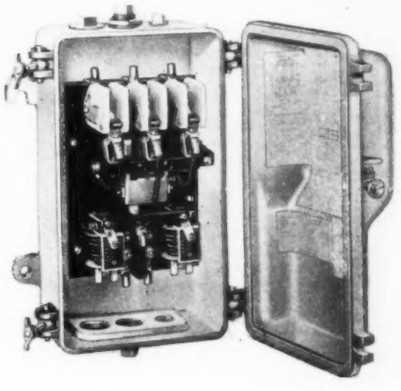
Built-in applications of this pump are as follows: Air conditioning apparatus; dish, bottle, can and metal-parts washing machinery; filters and filter systems; dairy equipment; core sucking units, and others. The pump is built in ratings of ½ to 5 hp. in a large number of steps to suit various heads and outputs. The maximum head pumped is 115 ft., or approximately 50 lb. per sq.in.

Du Pont No. 1130 Metal Lacquer

Protection of hardware from crystal spotting on oxidized finishes, stain spotting on cast work, and from green drip or tarnishing is afforded by the No. 1130 clear metal lacquer developed by the E. I. DuPont de Nemours & Company, Inc., Parlin, N. J. This lacquer has been formulated especially to meet the demands of the hardware trade, and is also offered for use where the above deteriorating effects are to be avoided in other metal products. The lacquer will also give maximum resistance to the deteriorating effect of outdoor exposure; maximum adhesion to the metal; maximum hardness without sacrifice of flexibility; maximum flexibility, and non-discoloration of film on aging. The average mean of the evaluation of tests on the properties of the No. 1130 lacquer and others was 90, which is 50 per cent better than the rating of 60 for Du-Pont 1110 clear metal lacquer, which has been on the market for some years.

Allen-Bradley Splash-Proof Starter for Squirrel-Cage Motors

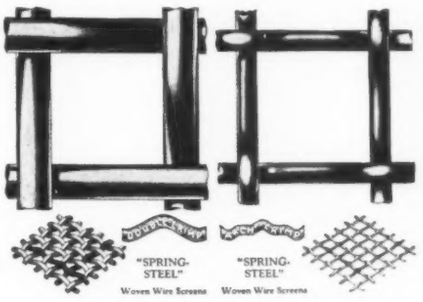
The Allen-Bradley Company, 1311 S. First St., Milwaukee, Wis., has announced the Bull. 710 WT across-the-line starting switch for use in places where a splash-proof starter is necessary. The starters are rated for



squirrel-cage motors up to and including 100 hp., 220 volts, and 200 hp., 440-550 volts. On slip-ring motors they serve to control the primary circuit up to and including the maximum rating listed for squirrel-cage motors. If the thermal-relay reset button is omitted from the side of the cabinet, this starter is entirely watertight.

Ludlow-Saylor "Spring Steel" Woven-Wire Screens

A full line of alloy-steel, woven-wire screens in coarse meshes has been announced by the Ludlow-Saylor Wire Co., Newstead Ave. & Wabash Railroad, St. Louis, Mo. These screens are suitable for service on revolving-screen jackets and vibrating-screen sections, and for various other applications where screens are required for rough, abrasive work. They are offered for crushing, grinding and screening machinery under the trade name of "Spring Steel," and there are approximately 250



grades and meshes. These range from 4-in. openings made of heavy bars down to $\frac{1}{16}$ in. openings of No. 20 wire. As illustrated, these screens are made in two styles, "Double-Crimp" and "Arch-Crimp." The "Double-Crimp" screen is cold-worked at every crimp, to develop maximum hardness, toughness and interlocking pressure. The "Arch-Crimp" screen is made so that the wires will not creep or rub, and the crimps cannot slip or stretch.

Robbins & Myers Washing-Machine Motors

Robbins & Myers Sales, Inc., Springfield, Ohio, has announced a ¼-hp., 1,750 r.p.m. motor of split-phase design for use on washing machines and similar appliances. This motor weighs only 19 lb., and has a wool-yarn lubrication system and an extra large shaft.

The starting switch is of the centrifugal type, with the wiping leads constructed for minimum wear by friction. The leads are brought out through a molded block, which can be removed quickly to permit reversal of the direction of rotation.

PUBLICATIONS

FOR THE ENGINEER'S LIBRARY

BALL AND ROLLER BEARINGS. The Bantam Ball Bearing Co., South Bend, Ind., has issued manual No. 11 on its line of ball and roller thrust and radial bearings. For the first time dimensions and load capacities of heavy duty type roller bearings up to 29½-in. bore and 48-in. O.D. are published. Special bearings are also illustrated, as well as recommended mountings and enclosures. Engineering data are appended.

BALL BEARING MOUNTINGS. The Fafnir Bearing Co., New Britain, Conn., has issued a 12-page booklet under the title of "Typical Mountings for Ball Bearings," giving suggestions for the design of such mountings with a number of illustrative diagrams.

CHAIN DRIVES. The Morse Chain Co., Ithaca, N. Y., has issued a new catalog on Morse Silent Chain Stock Drives, numbering it No. 44. The 56 pages of the Bulletin give the buyer necessary information for the selecting of the type of drive required and the price. It is arranged in convenient tabular form.

COLD FINISHED BARS. Joseph T. Ryerson & Son, Inc., 16th & Rockwell Sts., Chicago, Ill., has issued a bulletin describing the cold finished bars and cold finished steel supplied by the company.

CONTROLS. The General Electric Co., Schenectady, N. Y., has issued Catalog GEA-606C for 1931 on "Industrial Controls," comprising 196, 8½ x 10-in. pages.

CONTROLS. The Shallcross Control System Co., Milwaukee, Wis., has brought out a new loose-leaf catalog on the various controls for gases and liquids.

ELASTIC PROPERTIES OF ALLOYS. The University of Nevada, Engineering Experiment Station, Reno, Nev., has published "Tables of Elastic Properties of Alloys," compiled from many sources with the object of presenting in compact form the compositions and elastic properties of alloys, including the endurance limit where possible, to serve as a reference in design work. Copies cost 20 cents.

FLUID POWER. The Oilgear Co., Milwaukee, Wis., has issued Bulletin 10100 on the Oilgear fluid power principle. In this four-page leaflet, the principle of operation of Oilgear variable-delivery pumps and fluid motors is explained with the aid of diagrammatic sketches and photographs of the principal components.

GASKETS. The Victor Mfg. & Gasket Co., 5750 Roosevelt Rd., Chicago, Ill., has issued Catalog H on gaskets, gasket materials and packings, containing 94 pages of information on the company's gaskets and similar products.

GEARS. The Earle Gear & Machine Co., 4707-15 Stenton Ave., Philadelphia, Pa., has issued catalog No. 31 containing 100 pages on its products, and including photographs, engineering data and formulas.

LACQUERS. The General Electric Co., Schenectady, N. Y., has issued a bulletin entitled "Glyptal Lacquers and their Applications," in which are given the results of various tests, illustrating the properties of these materials, and also applications to a wide range of products.

LACQUER. The E. I. du Pont de Nemours & Co., Wilmington, Del., has prepared a bulletin entitled "A Clear Metal Lacquer for Metal Protection," which describes various tests made on the new No. 1130 clear metal lacquer and giving a table comparing the results of these tests with tests of other lacquers on the market.

MOTORS. The General Electric Co., Schenectady, N. Y., has issued a series of revised bulletins on various types of its motors as follows: Bulletin GEA-61C, superseding 61B, on Type CD constant-speed d.c. motors; GEA-712B, superseding 712A, on Type BTA motors of the adjustable-speed, a.c. brush-shifting type; GEA-752A, superseding 752, on Type BD d.c. motors of constant-speed and adjustable-speed design; GEA-894, superseding in part 223, on Type CD, adjustable-speed d.c. motors; GEA-1326A, superseding 1296, on Type CR9517 brakes for d.c. motors; GEA-1326A, superseding 1326, on Type K, totally-inclosed, fan-cooled induction motors; GEA-1341A, superseding 1341, on explosion-proof, totally-inclosed fan-cooled induction motors; GEA-1383, superseding 1303A and 6A, on general-purpose, squirrel-cage induction motors with open, horizontal frames, and GEA-1412, superseding 456, on type K, solid-shaft vertical induction motors.

NICKEL BRASS AND CHROME BRASS. The American Nickeloid Co., Peru, Ill., is distributing a folder containing samples of nickel brass and chrome brass which are finished corrosion-resistant materials with the strength and forming properties of solid brass.

NICKEL STEEL SPECIFICATIONS. The International Nickel Co., 67 Wall St., New York, N. Y., has issued Recommended Railroad Specifications Nos. 1 to 8 on forging billets, normalized and tempered low-carbon forgings, boiler and firebox plates, castings, engine bolt steel, low-carbon main frames for locomotives, nickel staybolt steel, and nickel cast iron for cylinders. The data are presented in a similar form to that used by the American Railway Association for their standard specifications. Additional specifications will be issued later.

PIPE FITTINGS FOR WELDING. The Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill., has issued Bulletin 31-1 on Taylor Forge Fittings, describing the company's line of seamless steel pipe fittings for welding.

PLASTIC PRODUCTS. The General Electric Co., Schenectady, N. Y., has issued a bulletin entitled "Plastic Products Price List," being bulletin GEA-937B, superseding 937A.

PLASTICS. A bulletin entitled "Plastic Products" has been issued by the Plastics Division at Lynn, Mass., of the General Electric Co., containing a brief summary of the company's plastic products and the parts that may be formed therefrom.

PRESSURE PIPE LINES. The Engineering Department of the American Rolling Mill Co., Middletown, Ohio, has recently issued a bulletin under the title "Designing Pipe Lines for Pressure," giving engineering information on that subject.

SHEET STEEL PRODUCTS. The Inland Steel Co., First National Bank Bldg., Chicago, Ill., has issued a new edition of the booklet "Inland Open Hearth Sheet Steel Products," containing all information, brought up to date, ordinarily needed for ordering steel sheets. Standard extra and differentials, sheet weights, and bundling tables, standard commercial tolerances, and trade customs and practices are included as well as concise descriptions of all Inland sheet steel products. The booklet is coat-pocket size, containing 56 pages of condensed data.

SPEED REDUCERS. The W. A. Jones Foundry & Machine Co., 4401 Roosevelt Road, Chicago, Ill., has issued bulletin No. 53 on Small Herringbone-Maag Speed Reducers for Small Motor Drives, describing the No. 90-D and 105-D units recently brought out by the company.

SPINDLE AND BEARING MOUNTING. "Simplified Spindle and Bearing Mounting Designs" is the title of Bulletin No. 102, issued by the Wyrick Engineering Co., Wyandotte, Mich., describing and diagramming various spindle bearing designs and giving tabular data on the company's products.

STAINLESS STEELS. The Republic Steel Corp., Massillon, Ohio, has issued a folder on Enduro-FC free-cutting stainless steel, containing authentic information on the alloy, including such information as analyses, physical properties, properties at high temperatures and instructions for working.

TIME CYCLE CONTACTORS. The Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia, Pa., has prepared Bulletin 1212 on the application of time cycle contactors to various process equipment. The contactors are offered in manual, semi-automatic, and automatic types.

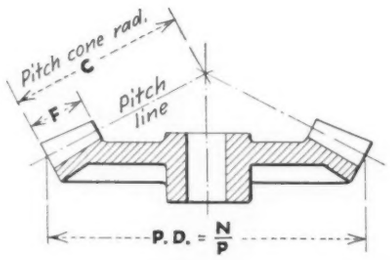
WELDED GEAR BLANKS. A single-page bulletin describing gear blanks made of arc-welded rolled steel has been issued by Lukenweld, Inc., Coatesville, Pa. This short bulletin is preliminary to a more complete engineering bulletin to be published later.

Strength Factors for Bevel Gears

The strength factor of a spur gear of equivalent number of teeth multiplied by a correction factor ($1 - M + \frac{1}{3}M^2$) which expresses the ratio of the strength of a bevel gear to that of a spur gear of the same pitch and number of teeth, gives the strength factor of a bevel gear.

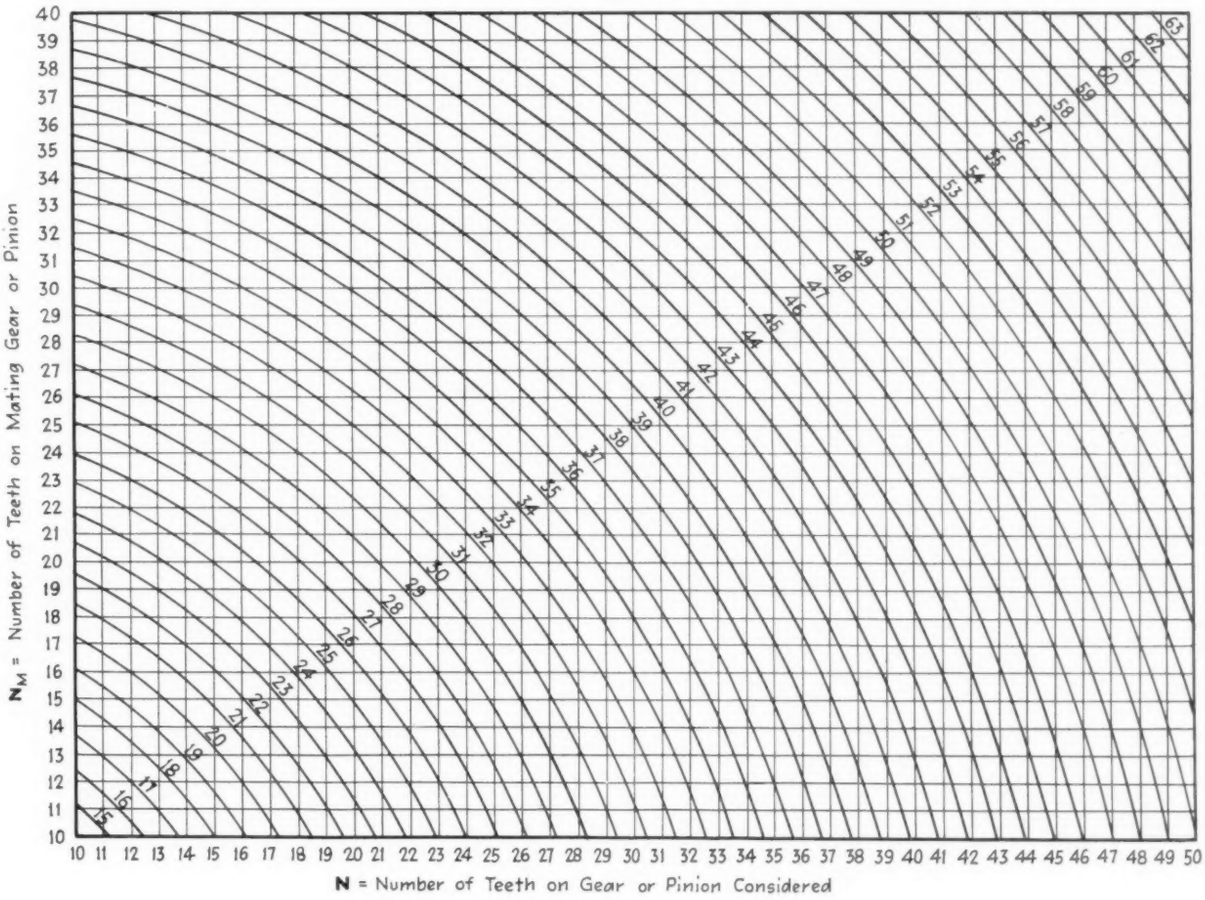
$$S.F. = \frac{F \times Y'}{P}\left(1 - M + \tfrac{1}{3}M^2\right)$$

where $$M = \frac{F}{C} = \frac{2F \times P}{\sqrt{N^2 + N_M^2}}$$



F = *Face of tooth in inches*
P = *Diametral pitch*
Y' = *Lewis outline factor for* N' *teeth*
$N' = \frac{N}{N_M}\sqrt{N^2 + N_M^2}$ = *Equivalent number of teeth*
N = *Number of teeth on gear or pinion considered*
N_M = *Number of teeth on mating gear or pinion*
$\left(1 - M + \frac{1}{3}M^2\right)$ *is derived from Lewis formula correction factor. From 10th edition Kent Handbook, p. 1672*

An aid to computation in the above formulas is given below by the chart from which $\sqrt{N^2 + N_M^2}$ *is determined.*



Read $\sqrt{N^2 + N_M^2}$ *on arc scale.*

Example:- $N = 18,\ N_M = 42,\ \sqrt{N^2 + N_M^2} = 45.7$

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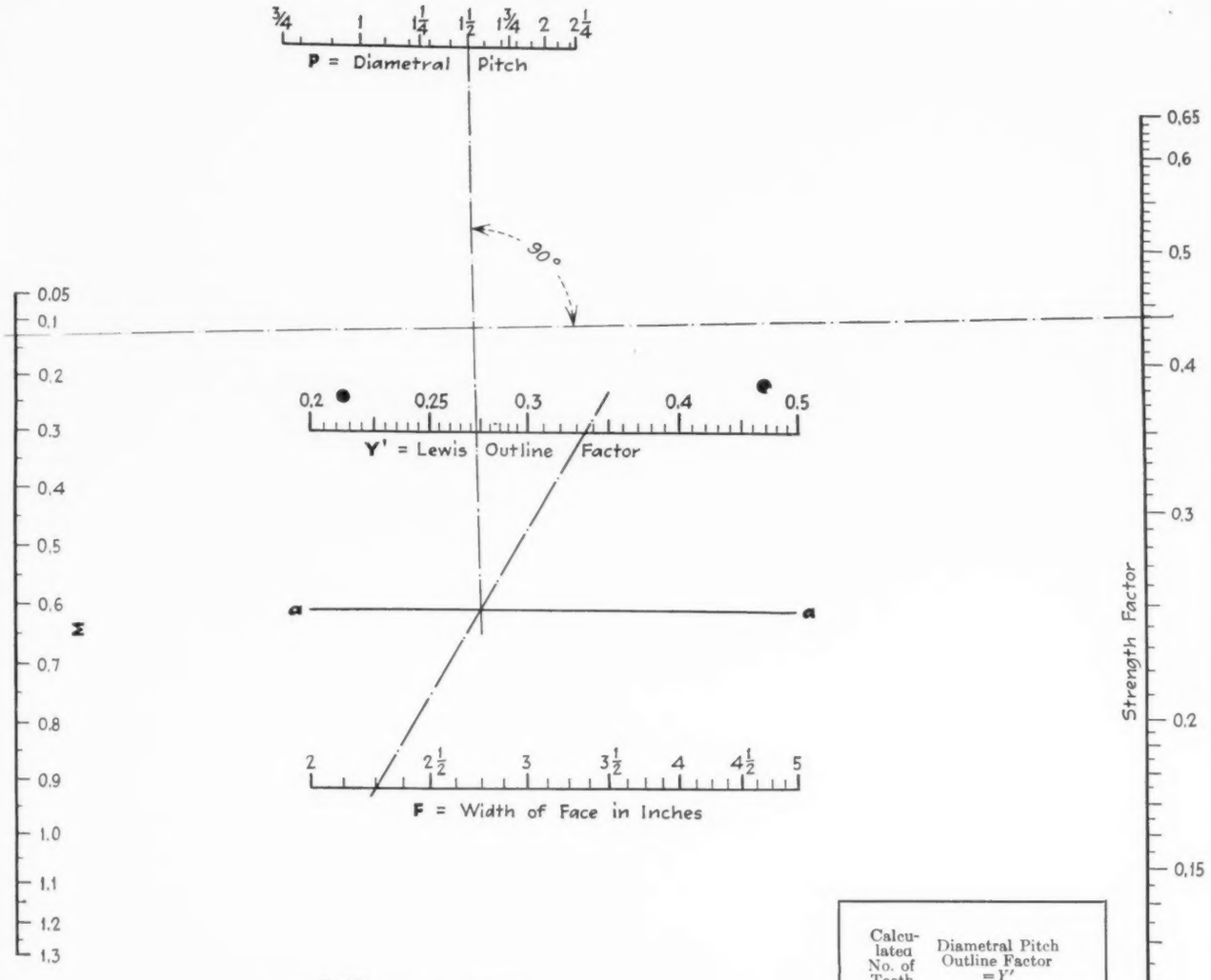
Strength Factors of Bevel Gears



$$S.F. = \frac{F \times Y'}{P}\left(1 - M + \frac{1}{3}M^2\right)$$

To determine the strength factor, having given the number of teeth on the gear (N = 30), the number of teeth on the mating gear (N_M = 40), F = 2¼" and P = 1½":

1 *Calculate* M *from the formula* $M = \frac{2FP}{\sqrt{N^2 + N_M^2}} = 0.135$ *(See over)*

2 *Determine* Y' *for* N' *teeth.* $N' = \frac{N}{N_M}\sqrt{N^2 + N_M^2} = 37.5$

3 *Draw line through* F *and* Y' *scales at* F = 2¼ *and* Y' = 0.335, *intersecting line* a–a.

4 " " " P *scale at* P = 1½ *from above intersection on* a–a.

5 " " " M *and* S.F. *scales at* M = 0.135, *perpendicular to line 4. Then* S.F. = 0.438.

Calculated No. of Teeth = N'	Diametral Pitch Outline Factor = Y' 14½°	20°	20° Stub
12	.210	.245	.324
13	.220	.261	.336
14	.226	.276	.349
15	.236	.289	.355
16	.242	.295	.361
17	.251	.302	.371
18	.261	.308	.377
19	.273	.314	.380
20	.283	.320	.386
21	.289	.327	.393
23	.295	.333	.396
25	.305	.339	.402
27	.314	.349	.412
30	.320	.358	.418
34	.327	.371	.430
38	.336	.383	.443
43	.346	.396	.452
50	.352	.408	.465
60	.358	.421	.478
75	.364	.434	.490
100	.371	.446	.500
150	.377	.459	.512
300	.383	.471	.522
Rack	.390	.484	.534

Contributed by M. G. Van Voorhis, Draftsman, Thew Shovel Company

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